SCIENCE ABSTRACTS.

PHYSICS AND ELECTRICAL ENGINEERING.

NOVEMBER 1898.

GENERAL PHYSICS.

1201. *Conservation of Energy.* **J. R. Schütz.** (Göttingen Nachrichten, 2. pp. 110–123, 1897.)—The "absolute" conservation of energy for a single particle is expressed analytically by the equation

$$[X(u+\alpha)+Y(v+\beta)+Z(w+\gamma)]dt = d\frac{m}{2}[(u+\alpha)^2+(v+\beta)^2+(w+\gamma)^2].$$

Here u, v, w are the component velocities of the particle relative to a "physical" space, which physical space is itself moving with uniform component velocities α, β, γ; m is the mass of the particle, X, Y, Z the components of force.

The object of the paper is to show that from the principle of the conservation of energy so expressed, having regard to α, β, γ, Newton's three laws can be deduced.

As a simple example he supposes a central collision of two perfectly elastic spheres whose masses are m_1 and m_2, w_1 and w_2 their velocities in the line of centres before collision, ω_1 and ω_2 after collision. Then we suppose an observer to know the law of conservation of energy relative to the physical space in which the spheres are, but to know nothing whatever else. Then he knows that

$$\frac{m_1}{2}w_1^2+\frac{m_2}{2}w_2^2=\frac{m_1}{2}\omega_1^2+\frac{m_2}{2}\omega_2^2,$$

which does not suffice to determine ω_1 and ω_2. But if he be now informed of the complete or "absolute" expression for the conservation of energy in this case, namely

$$\frac{m_1}{2}(w_1+\alpha)^2+\frac{m_2}{2}(w_2+\alpha)^2=\frac{m_1}{2}(\omega_1+\alpha)^2+\frac{m_2}{2}(\omega_2+\alpha)^2$$

for all values of α, he can determine ω_1 and ω_2. That is, in effect, the motion can be determined as it would be from Newton's laws; or Newton's laws can be deduced from the conservation of energy.
S. H. B.

1202. *Translational Motion of the Ether.* **W. Wien.** (Annal. Phys. Chem. 65. 3. i–xviii, 1898.)—The author gives a general survey of the state of the question regarding the non-rotational and non-vibrational motion of the ether. The tendency to connect the properties of the ether with those of ponderable matter has led to the assumption that the ether is capable of motions similar to those of a fluid. The author shows that if the ether has zero inertia and zero compressibility, the motion of electric quantities need not imply the motion of the ether. But such motion takes place when the ether has a finite density, and also when plane electromagnetic waves are reflected by moving insulators. The latter case might possibly be experimentally investigated. The assumption of a stationary ether, though useful for optical theory, offers only an extremely vague mental image. Lorentz has, indeed, shown that a vast number of phenomena may be satisfactorily explained on the assumption of a stationary ether, but that assumption is open to an elementary objection. If a body in the shape of a thin plate is freely immersed in the ether, and its two faces have different radiating powers for heat, the pressure due, by Maxwell's theory, to the radiation would be different on the two faces, and the body would put its own centre of gravity in motion without creating an equal and opposite momentum. It is possible that the ether is only carried along by large bodies, such as the earth, owing to some gravitational effect. It would be well to repeat the experiments of Mascart on the influence of the earth's motion on the rotation of the plane of polarisation in quartz, and those of Röntgen on the magnetic forces excited by moving electric charges, which had negative results.
E. E. F.

1203. *New Sprengel Mercury Pump.* **E. Müller.** (Annal. Phys. Chem. 65. 2. pp. 476–478, 1898.)—This is a semi-automatic pump, independent of water-power or an auxiliary pump. It requires only about 3 kgr. of mercury to work it; but one of the reservoirs has to be refilled by hand about every hour. E. E. F.

1204. *Thermo-Electric Measurement of Strains in Iron and Steel.* **Turner.** (Écl. Électr. 15. pp. 416–417, 1898.)—When a metallic wire is stretched it cools, and the cooling can be measured by a thermo-electric junction attached to the wire. When the stress does not exceed five-eighths of the limit of elasticity, it can be exactly measured by the change of temperature. Analogous phenomena are observed in the case of compression. Turner employs a bismuth-antimony junction and a Thomson galvanometer. His first experiments were made on bars of soft and moderately soft steel, of cast iron, and on small columns of steel;

they showed that the galvanometer deflections were proportional to the tensions and compressions. Experiments of greater interest were made on pieces complicated in form, or that presented imperfections of manufacture which can neither be evaluated by theory nor ordinary physical tests. E. C. R.

1205. *Expansion of Tri-metallic Cylinder.* **S. Schwendener.** (Berlin. Akad. Sitzber. 12. pp. 172–175, 1898.)—A circular cylinder is made of longitudinal strips of copper, iron, and zinc; chosen because they possess unequal coefficients of thermal expansion. On heating the cylinder it both bends and *twists.* The author has a theory that certain characteristic growths of certain parts of plants are due to unequal rates of increase. The experiment has a bearing on the theory. A. Gs.

1206. *Richard Planimeter.* (Électricien, 15. pp. 193–196, 1898.) This integrator comprises two parallel discs mounted on a common axis and adapted to be rotated in opposite directions at the same velocity, this being effected by providing their peripheries with teeth engaging with a common independently-mounted pinion, and driving one disc from the axis, the other being free to turn thereon. Between the adjacent perfectly-polished surfaces of these discs is a spheroidal roller of polished steel, fixed on an arbor mounted between centres in a frame which is guided so that the roller shall move along a radius of the rotary discs. On the arbor of the roller is an elongated pinion which gears with a gear-wheel forming part of a counting train, the pinion being of sufficient length to permit the roller to move from the centre to the periphery of the rotary discs without the pinion being thrown out of gear with the gear-wheel. The curve to be integrated is placed on a drum which is adapted to be rotated from the same arbor as that whereby motion is imparted to the rotary discs. Over this drum moves a stylus mounted on the end of an arm, turning about fixed centres and having a toothed segment thereon gearing with a rack on the frame carrying the spheroidal-roller arbor, the parts being so arranged that when the stylus is on the axis of x, the roller will be at the centre of the rotary discs, and therefore the said roller will not be rotated. The number of turns made by the roller is proportional to the area between the curve and the axis of x. There are four dials on the instrument described, indicating respectively units, tens, hundreds, and thousands of square millimetres. C. K. F.

1207. *Laplace's Barometric Formula.* **A. Angot.** (Comptes Rendus, 126. pp. 826–828, 1898.)—A discussion is given of the barometric formula of Laplace. J. J. S.

1208. *Oxygen in Helium Stars.* **F. McClean.** (Roy. Soc. Proc. 62. pp. 417–423, 1898.)—The author has recently returned from the Cape, where he has obtained the spectra of 116 stars with the aid of his large objective prism attached to the Astrographic Chart telescope at the Observatory there. In his discussion of the spectra he finds in many of the stars what he calls "extra" lines, outstanding from the usual helium and hydrogen lines; and to show the probability of these being due to oxygen, he maps the spectrum of oxygen alongside the stellar spectra. The evidence afforded by the many apparent coincidences seems to him to be sufficient to warrant their being accepted as oxygen lines.

C. P. B.

1209. *Celestial Phenomena and Kathode Rays.* **H. Deslandres.** (Comptes Rendus, 126. pp. 1323–1326, 1898.)—The author, profiting by his observations of the total eclipse of the sun in 1893 to investigate the chromosphere and corona, traces a connection between these phenomena and the appearances exhibited by various combinations of kathode rays. His special experiments with kathode rays have been described in a former paper (Comptes Rendus, 124. pp. 678, 945, 1297, and 125. p. 373). The two points to which he draws special attention are (1) the attraction exerted by an anode on a kathode ray; (2) the non-repulsion by a kathode when a solid body is interposed in the path. In the eclipse of 1893 the author says he found certain regions of the solar surroundings to emit kathode rays. He regards the base of the solar atmosphere as being the seat of this emission, the rays being most intense where the chromosphere is brightest, viz. above the spots and faculæ. By considering the combined result of the solar attraction and the kathode ray repulsion on particles of matter surrounding the sun, he explains the production of the corona and comets. He regards the light of these objects to be produced by the heat and phosphorence induced by the impact of the kathode rays upon the matter surrounding the sun. The fact of the tails of comets being always turned from the sun is also explained. The particles of matter are assumed very small. Then the attraction being proportional to the mass, and the kathode repulsion proportional to the surface, the latter may eventually overcome the former; hence the outward direction of the cometary appendages. Perrin is cited as authority for stating that the kathode ray carries a negative charge, which will modify the electric and magnetic state of the sun, thereby producing such phenomena as auroræ and terrestrial magnetic storms. In conclusion the author points to a possible proof of his view. The varying periods of brightness of comets should correspond to the passage of some large sun-spot or facula near the line joining the comet to the sun's centre. C. P. B.

LIGHT.

1210. *Electrodynamic Slit Action.* **M. Latrille.** (Annal. Phys. Chem. 65. 2. pp. 408–430, 1898.)—A narrow slit transmits polarised light to a different extent according to the angle between the slit and the plane of polarisation of the light. In electromagnetic waves a similar observation is made. The greatest transmission is obtained when the slit is perpendicular to the direction of the vector of electric force. The author investigates the dependence of the transmitted energy upon the width of the slit. The indicator used is a coherer, and it is found that the direction of the axis of the latter also influences the result, since it reacts more strongly upon electric vibrations along its axis than across it. When the slit is increased in length, the energy transmitted increases rapidly at first, and then more slowly. When the width is increased, the energy transmitted increases slowly at first, and then at a greater rate, up to a certain maximum. The absorption is due to the resonance of the edges of the slit. E. E. F.

1211. *Ketteler-Helmholtz Dispersion Formulæ.* **A. Pflüger.** (Annal. Phys. Chem. 65. 1. pp. 173–213, and pp. 225–228, 1898.) —The formulæ are

$$n^2-\kappa^2-1=\Sigma\frac{D\lambda^2(\lambda^2-\lambda_m^2)}{(\lambda^2-\lambda_m^2)^2+g^2\lambda^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$2n\kappa=\Sigma\frac{Dg\lambda^3}{(\lambda^2-\lambda_m^2)^2+g^2\lambda^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

To test them experimentally, let corresponding values of λ, n, κ be observed: then, by a tentative process, a set of values (λ_m, g) are found so that the graphs for

$$\left.\begin{aligned} y&=\frac{2n\kappa}{\lambda^3} \\ \text{and} \qquad y&=\Sigma\frac{Dg}{(\lambda^2-\lambda_m^2)^2+g^2\lambda^2} \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

agree. Now (1) may be written in the approximate form

$$\left(n^2-\kappa^2-a-\frac{b}{\lambda^2}+c\lambda^2\right)\frac{1}{\lambda^2}=\Sigma\frac{D(\lambda^2-\lambda_m^2)}{(\lambda^2-\lambda^2_m)^2+g^2\lambda^2}, \quad . \quad . \quad (4)$$

where a, b, c are constants, and the values of (λ_m, g) on the right hand are the same as those calculated from (3). Three separate determinations of n, κ fix the constants a, b, c; and if, for these values, the equation (4) is approximately satisfied for a wide range of λ, this is, so far, a confirmation of the original formulæ (1) and (2).

The object of this research is to test the theory by observations upon *solid* substances showing anomalous dispersion, and for this purpose cyanin and fuchsin were selected. To determine κ, the index of absorption, thin films of the pigment were deposited on glass plates, and their thickness found by Wernicke's modification of Wiener's method; κ was then deduced from observations with König's spectral photometer. The values of n (the index of refraction) for fuchsin in the ultra-violet were found by a method suggested by Kayser. An iron spectrum of wide dispersion was obtained by means of a narrow slit and a Rowland concave grating of 6·5 m. focal length. The rays of a portion of this fell upon a double prism of fuchsin deposited on a quartz plate, and after this upon a photographic plate, where two images of each spectral line were produced. Let d' be the distance between them: then, if the double prism is sufficiently far from hephotographic plate,

$$n=\left(\beta+\frac{d'}{\delta}\right)/\beta,$$

where β is the sum of the very small angles of the prism, in seconds, and δ is the (calculated) value of d' for an angular deviation of one second. The values of n for cyanin in the visible part of the spectrum were also carefully determined directly by means of a spectrometer: the results are tabulated and compared with the author's previous results.

The final conclusion is that, so far as the visible spectrum is concerned, the Ketteler-Helmholtz dispersion-formulæ, applied to media whose optical constants are exceedingly variable within a very small range of wave-length, are (allowing for unavoidable experimental errors) so far consistent with observation that they account for the greater part of the two graphs

$$y=\frac{2n\kappa}{\lambda^3},\quad y=\left(n^2-\kappa^2-a-\frac{b}{\lambda^2}+c\lambda^2\right)\frac{1}{\lambda^2},$$

which are deduced from experiment. There is, however, a discrepancy for the red part of the spectrum.

In the supplementary paper it is remarked that the optical constants of cyanin, deduced indirectly by means of Cauchy's formulæ for metallic reflection [see No. 1212], agree very well with the values observed directly, *except* for the red part of the spectrum. For this the values of n agree with those observed, but the values of κ come out larger. If these larger values of κ are used, the discrepancy above alluded to disappears. G. B. M.

1212. *Optical Constants of Solid Cyanin.* **A. Pflüger.** (Annal. Phys. Chem. 65. 1. pp. 214–224, 1898.)—This is an account of the determination of the optical constants n and κ for solid cyanin by means of Cauchy's formulæ for metallic reflection, and an experimental method already employed by Quincke and Walter. When the results are compared with the author's previous direct determinations [see No. 1211], the values of n are in good agreement throughout; the new values of κ in the red, however, are larger than those found directly. Taking the larger values to be correct, a discrepancy noticed in the author's paper on dispersion disappears. The conclusion arrived at is that Cauchy's formulæ give the values of n and κ with sufficient exactness, and that the best and simplest way of testing the theory of dispersion is by means of experiments on reflection, supposing that superficial lamination can be avoided. G. B. M.

1213. *Refractive Index of Minerals by Total Reflection.* **C. Klein.** (Berlin. Akad. Sitzber. 28. pp. 317–331, 1898.)—The author describes two convenient pieces of apparatus for the determination of the indices of refraction of thin sections; one is made on Kohlrausch's, the other on Abbe-Gapski's principle. There is given a list of liquids, the refractive indices of which lie between pairs of minerals of not greatly different refractive power, and which serve to specify minerals in doubtful cases. A. Gs.

1214. *Change of Wave-Length by Pressure.* **J. Wilsing.** (Ast. Phys. Journ. 7. pp. 317–329, 1898.)—The author wishes to show that the changes in wave-length produced by pressure as determined by Messrs. Humphrey and Mohler [Ast. Phys. Journ. 3. p. 114, 1896; 4. pp. 175, 249, 1896; 6. p. 169, 1897] may be explained as an effect of damping of the vibrations to which the emitted light is due. Increase of pressure always moved the lines towards the *red* end of the spectrum, that is *increased* their wave-length. Also the amount was different for lines of different elements, but in the case of various lines of the same substance, the change was related to the position of the line in the harmonic series expressing the spectrum. Special significance attends the remark that the lines do not become *broadened*, as is the result of simple change of density, as this would show that the shift could not be produced by any *unsymmetrical* broadening of the lines. Attention is drawn to the observations of Kundt, who found that the absorption-bands of substances dissolved in transparent media were displaced also towards the red, the extent depending directly on the dispersion of the transparent medium.

The author gives Lommel's analysis for the case of a damped simple harmonic vibration subject to a periodic impulse, the result of which is to indicate a displacement of the line towards the red when the vibration is damped. Thus far it is in accordance with observation, but the theory goes on to require that the dark absorption-bands shall suffer the same change, and also that the *breadth* of the line shall vary. Both these latter results are contrary to observation. The author then introduces a modification of Ketteler's, originally due to Bessel, whereby the influence of internal friction was considered. This, so far, modifies the results obtained by Lommel, that no widening of the lines is indicated, and the change in the absorption-lines is different from that of the emission-lines. The author concludes with an interesting discussion of the application of these changes of spectral lines to the explanation of new stars, etc. C. P. B.

1215. *Wave-length of Mercury Rays.* **Ch. Fabry** and **A. Perot.** (Comptes Rendus, 126. pp. 1706–1708, 1898.)—Measurements have been made by an interferential spectroscope (Comptes Rendus, 126. pp. 34, 331, 407) by the method of counting the number of coincidences in a given length (up to 32 mm.). Michelson's measurements of the cadmium rays were taken as standard. The rays of mercury are two in the yellow, one in the green: the less refrangible of the yellow is double, with the minor component above the principal one by $\Delta\lambda/\lambda=-22{\cdot}5\times10^{-6}$; the other yellow ray has a minor component below the principal by $\Delta\lambda/\lambda=8{\cdot}3\times10^{-6}$. The results are, in air at 15° and 760 mm.:—

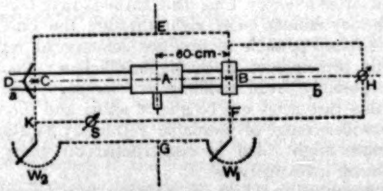
1st yellow ray	$\lambda=0{\cdot}57906593\ \mu$.
2nd "	$\lambda=0{\cdot}57695984\ \mu$.
Green ray	$\lambda=0{\cdot}54607427\ \mu$.

R. A. L.

1216. *Astigmatism.* **R. Straubel.** (Annal. Phys. Chem. 64. 4. pp. 794–808, 1898.)—Two cylindrical lenses are arranged in such a way that the astigmatism of the combination is variable; they can be turned against one another in their plane. If the axes of the two lenses are parallel, the combination acts like a plane plate; if crossed, in one direction, as a convex lens; if in the other direction at right angles to the former, as a concave lens. The astigmatic difference, *i. e.* the difference of the reciprocals of the two main radii of curvature would be double that of a single lens. The paper is mathematical. The combination may be applied for three purposes:—Firstly, for the production and demonstration of astigmatism. Secondly, for its compensation in the eye or in optical instruments; neither of these applications will be easy unless the defects be regular. Thirdly, for the determination of astigmatism of the eye and for the examination of deformed surfaces. H. B.

1217. *Photometry of Incandescent Lamps.* (Electrician, 41. p. 426, 1898.)—The rules for the photometry of incandescent lamps approved by the Verband Deutscher Elektrotechniker are as follows:—By candle-power is understood the mean candle-power in the plane perpendicular to the axis of the lamp. This is determined by the arrangement sketched in the accompanying figure; *a*, *b* represents a straight photometer bench, 2·5 metres long; A the photometer; B an auxiliary source of light; C the lamp to be tested or the standard lamp; and D a pair of mirrors placed at an angle of 120°. The distance between A and B is 60 cm., and must be adjustable to 6 cm. longer or shorter. The mirrors are two square pieces of good, flat, silvered glass, 13 cm. side. The vertical line between the mirrors is placed so that its distance from the axis of the lamp C is 9 cm. The axis of the lamp is to be vertical, and the ends of the filament must lie in a plane perpendicular to the axis of the photometer. The photometer-scale is to be divided into tenths of a candle-power. The photometer-screen is to be protected from outside sources of light by black screens, preferably of velvet; but the lamps, or their reflection, must not be screened in any way.

Fig. 1.



As standards, lamps taking 3·5 to 4·5 watts per candle-power are used, which have approximately the same voltage and exactly the same candle-power as the lamp to be tested should have. The auxiliary source of light should be a faultless 10 c.p. lamp, also for approximately the same voltage. To avoid changes in the candle-power it is advisable to burn these lamps 20 to 30 hours before use.

For the measurement of the pressure the two circuits EFG and EKG are connected in parallel, the one including the lamp B and the adjustable resistance W_1, the other the lamp C and the adjustable resistance W_2. Between K and F a voltmeter for measuring small pressures is placed, and a voltmeter H is connected to B, to enable the required pressure to be maintained at the terminals of this lamp by altering the adjustable resistance W_1. The voltmeter S indicates the difference in the voltage between the two lamps, and is adjusted by the resistance W_2.

To take measurements, the auxiliary lamp B is first given the correct pressure. The standard is then placed at C and the photometer-screen is placed at a distance corresponding to the standard and a balance is obtained by moving B. The distance AB is then kept constant, and a balance is obtained with the lamp to be tested placed at C. W. G. R.

1218. *Kathode and Röntgen Radiations.* **A. A. C. Swinton.** (Royal Institution Discourse, Feb. 4th, 1898; Electrician, 41. pp. 246–248, and pp. 317–319, 1898.)—A pear-shaped Crookes' tube is suspended over a straight electro-magnet, towards one pole of which the kathode beam is projected. When the magnet is excited, the beam is drawn down to a fine point, which rapidly erodes the internal glass surface of the tube. By moving the tube or the magnet, any desired pattern can be engraved on the glass. In another experiment two concave kathodes are arranged to focus on a small piece of quicklime, placed between them. The kathodes are supplied with alternating current at about 20,000 volts, and a very brilliant and beautiful light is produced by the incandescence of the quicklime. The light is found to fluctuate in a curious manner, and after a short time the kathode rays bore perfectly straight and very minute holes, right through the lime. It may eventually be found possible to produce commercial high voltage lamps on this principle of much higher efficiency than filament lamps, and possibly even rivalling arc lamps. The luminous material in this case need not be a conductor, and there is therefore a much wider range of available refractory substances. An electric furnace might also be constructed on these lines, for delicate chemical investigations.

A tube is described in which, in addition to a concave kathode and anode arranged as in a focus tube, there is a delicately pivoted wheel, with mica vanes, which can be moved bodily either out into the centre of the tube, so that the kathode stream impinges upon the vanes, or back into an annex, when the vanes are quite outside the kathode line of fire. In the former position, as in Crookes' experiments, the wheel revolves very rapidly in a direction that indicates a stream of particles proceeding from the kathode, but when placed in the latter position the wheel is found to rotate more slowly in the opposite direction. It appears, therefore, that in a focus tube, while the kathode stream proceeds at great velocity through the centre of the bulb, there is also a slower reverse stream of particles returning from the anode to the kathode, round the outside of the kathode stream.

When the stream from a concave kathode is caused to impinge upon an anti-kathode of carbon, the latter becomes luminescent where struck. If the anti-kathode be so placed as to intersect either the convergent or divergent cones of rays, these, instead of producing a uniformly luminous patch upon the carbon, produce a bright ring with a dark interior. The diameter of the ring is smaller the higher the exhaustion and the nearer to the focus the point of intersection. From this it appears that the convergent and divergent cones of kathode rays are hollow in section.

Birkeland's kathode-ray spectrum, produced by deflecting a thin kathode stream by a magnet, and then allowing it to fall upon the glass walls of the tube, can be photographed by binding a strip of sensitive photographic film round the tube, and making a single discharge through the latter. Further, by inserting between the glass and the film a piece of black paper, so placed as to cover only one-half of the spectrum, a photograph can be obtained, one half of which is due to the visible fluorescence of the glass and the other half to the invisible Röntgen rays. Such photographs show that the bands in the spectrum produced by the Röntgen rays are co-terminous with the fluorescent bands. It is suggested that the bands are due to kathode rays of different velocities, due to the oscillatory character of the discharge, those that travel fastest being the least deflected, and the most active in producing Röntgen rays.

When a focus-tube is fitted with two or more kathodes of different diameters, but all arranged to focus upon the same anti-kathode, it is found that for any given degree of vacuum the smaller the kathode put into use the greater is the E.M.F. required to cause a discharge to pass through the tube, and the more penetrative are the Röntgen rays produced. With a tube fitted with a movable anti-kathode, half of platinum and half of aluminium, either of which can be brought opposite to the kathode at will, platinum is found to give the most rays; while similar experiments with other metals show that the metals of the highest atomic weight form the best anti-kathodes. This is in accordance with what would be expected, if the Röntgen rays are due to sudden change in velocity of the kathode-ray atoms by collision with the anti-kathode.

The resistance of a tube, and the penetrative quality of the Röntgen rays produced, can be varied by making the anode (which also forms the anti-kathode) movable, when the nearer it is placed to the kathode the higher will be the resistance and the more penetrative the rays. According to another plan, the anode is fixed and the kathode is made movable relatively to the glass walls of a conical annex to the tube, when the nearer the kathode is to the glass the higher is the resistance and the more penetrative are the rays; or instead of making the kathode movable, a conical shield of glass is arranged so as to be adjustable relatively to the kathode, with a similar result. It is suggested that the increase of resistance in each case leads to a greater velocity of the kathode stream, and thus causes the Röntgen rays to be more penetrative. Curves showing the variations in resistance, and photographs illustrating the effect on the penetrative quality of the rays are given in the paper.

By means of pin-hole photography, the exact position, dimensions, and shape of the active area of the anti-kathode, from which the Röntgen rays proceed, can be investigated, and such photographs show that in a focus-tube the active area is a small spot, either alone or surrounded by a hollow elliptical ring of larger or less dimensions, depending upon the distance beyond the focus at which the anti-kathode intersects the kathode stream.

The photographic effect of the most powerful Röntgen rays that can be produced is relatively very feeble. A comparative test of a very good Röntgen-ray tube screened with black paper, as against a naked standard candle, showed that the candle was sixty times more active, photographically, than the tube.

The paper concludes with the suggestion that though Lodge was not able to detect any movement of the ether due to dragging a body through it, the very great velocity of the kathode-ray particles may have this effect, with the result that something analogous to the crack of a whip or a clap of the hands is produced as each particle hits the anti-kathode and rebounds; or the effect may be simply due to the enormous temperature attained by the kathode-ray particles on their kinetic energy being converted into heat in their collision with the anti-kathode, the energy, if all converted to heat in the particles themselves, being calculated to give a temperature rise of some 50,000,000,000 degrees Centigrade. AUTHOR.

1219. *Passage of Röntgen Rays along Opaque Tubes.* **E. Villari.** (Roma R. Accad. Lincei, Atti, 7. pp. 225–230, 1898.)—When sent along opaque tubes they neither gain nor lose in photographic effect, and accordingly they seem not to be sensibly reflected or diffused within the tube; and they probably do not lose any of their discharging power. A. D.

1220. *Röntgen Radiation and the Luminescence of Gases.* **A. v. Hemptinne.** (Zeitschr. Phys. Chem. 26. pp. 165–169, 1898.)—The author investigates the property of Röntgen rays of enabling a Geissler tube, through which they are passed, to give out light under a much lower vacuum. Therry suggested that the effect of Röntgen rays is not due to their ionising effect (at any rate primarily), but to the rays acting upon the ether in such a way as to facilitate electric discharge-sparks between molecules, the production of milliards of which sparks is the cause of luminescence of the gas. Luminescent gas is very like a metallic conductor in many ways, even including a screening effect; but it does not absorb Röntgen rays, as metals do. A. D.

1221. *Vacuum-Tubes that can be Regenerated.* **P. Villard.** (Comptes Rendus, 126. pp. 1413–1414, 1898.)—Affix a closed platinum tube to the Crookes tube. Exhaust to a high vacuum and seal. Heat the platinum tube for two or three seconds in a Bunsen flame: hydrogen traverses the platinum; air does not in the least. Five minutes of this will make the vacuum so low that the tube will not even act as a Geissler. By heating the platinum tube, protecting it from the Bunsen-flame gases, the process is reversed, and the vacuum may become so high that discharges from a powerful Ruhmkorff will not pass through it. Platinum-iridium, palladium, nickel, and even iron will act in a similar way. A. D.

1222. *Fluorescent Screens.* **P. Villard.** (Comptes Rendus, 126. pp. 1414–1415, 1898.)—If a portion of a barium platinocyanide screen be sheltered from Röntgen rays which impinge on the rest of it, and if the intervening obstacle be then removed, the part previously sheltered is now more brightly fluorescent than the remainder of the screen. A shadow-picture may thus be obtained when the object is removed. In full light it can be seen that the exposed portion is darkened as compared with the sheltered part; but this darkening disappears on exposure to daylight, and along with it the power of producing these shadow-pictures. It persists, however, if the affected screen be kept in the dark; and therefore such screens should not be put away in darkness after use. A. D.

1223. *Thorium Rays.* **G. C. Schmidt.** (Annal. Phys. Chem. 65. 1. pp. 141–151, 1898.)—Thorium and its compounds emit rays whose properties are identical with those of Becquerel's uranium rays, except that they are not polarised by tourmaline. The properties of the two kinds of rays are probably connected with their exceptionally high atomic weights, since no other metals emit them. Both uranium and thorium rays are refracted by glass. They affect the photographic plate, and impart a temporary conductivity to air. The latter property is not shared by the "rays" emitted by zinc, resin, and other substances, which are probably due to vaporisation. E. E. F.

1224. *Radiations from Compounds of Uranium and of Thorium.* **Sklodowska-Curie.** (Comptes Rendus, 126. pp. 1101–1103, 1898.)—All the compounds of uranium behave like uranium, and the more so the more uranium they contain. Oxide of thorium is more powerful than uranium itself. Uranium and thorium have the two highest atomic weights. Cerium, niobium, and tantalum compounds are slightly active. Yellow phosphorus is very active, perhaps from some other cause; red phosphorus and phosphates are not at all so. Pitch-blende (oxide of uranium) is more powerful than the metal itself; so is natural chalcolite (phosphate of copper and uranium), while artificial chalcolite is not: it seems as if these, as minerals, contained some element more powerful than uranium. The effects produced increase with the thickness of the material: much more so with thoria than with uranium. The radiations from thorium compounds are more powerfully absorbed by aluminium than those from uranium compounds; and the thicker the thoria layer the less absorbed are the rays from it. Thorium radiations have less photographic effect than uranium radiations. All these radiations are very much like Sagnac's secondary radiations. It is as if all space were constantly traversed by Röntgen rays of very high penetrative power only revealed by their being transformed into secondary radiations upon impinging on elements of very high atomic weight. A. D.

1225. *Radiations from Thoria.* **G. C. Schmidt.** (Comptes Rendus, 126. p. 1264, 1898.)—Results, as regards thoria compounds, like those of Mme. Sklodowska-Curie (Abstract No. 1224), and prior to hers. A. D.

1226. *Radiations from Uraninite.* **E. Villari.** (Écl. Électr. 15. pp. 32–33, 1898; Rend. della R. Accad. di Napoli, 1897.)—Uraninite gives off radiations similar to those from uranium and its salts. Air exposed to it will discharge a conductor, but cannot then discharge another of the same sign, though it will discharge one of opposite sign. Air exposed to uraninite is brought back to its natural condition by being passed between the plates of a charged condenser. The electric effect is not able to traverse cardboard as well as that of radiations from uranium, if at all.

A. D.

1227. *Phosphorescence in Low-Vacuum Tubes.* **F. Campanile** and **E. Stromei.** (N. Cimento, 4. 6. pp. 417–421, 1897.)—Phosphorescence in Geissler tubes is explained as being due to gradual charging and extremely rapid discharging of the walls of the tube at the part covered externally by the anodic tinfoil; the phosphorescence being set up on the opposite walls during the extremely rapid discharge. A. D.

HEAT.

1228. *Thermodynamics of a System which can exist in different States. I. Systems depending on a Single Normal Variable. II. Transformations of Sulphur. III. General Theory.* **P. Duhem.** (Zeitschr. Phys. Chem. 22. pp. 545–589; 23. pp. 193–266 & 497–541, 1897; Mém. de l'Acad. roy. de Belgique, 54. 1896.)—Imagine a system able to undergo continuous changes of equilibrium which are not reversible; from ordinary thermodynamics we can credit it with intrinsic energy E only, and assumptions are necessary to further progress. In the simplest case such a system would be defined by the absolute temperature T and a normal variable x, the work done *on* it during an infinitesimal change being therefore expressible in the form $\mathrm{X}dx$ (the normality of x consisting in this work being independent of $d\mathrm{T}$). Duhem then *assumes* that single-valued and continuous functions $\mathfrak{f}(x, \mathrm{T})$ and $f(x, \mathrm{T}, \mathrm{X})$ exist such that

$$\mathrm{E} = \mathfrak{f} - \mathrm{T}\partial\mathfrak{f}/\partial\mathrm{T},$$

$$d\mathrm{X} = (\partial^2\mathfrak{f}/\partial x^2)dx + (\partial^2\mathfrak{f}/\partial x\partial\mathrm{T})d\mathrm{T} + f\,|dx|,$$

where $|dx|$ denotes the absolute value of dx regardless of sign. (If $f=0$, then $\mathfrak{f}$ is the thermodynamic potential of the system, and may so be called in this more general case.) Through every point then on an xX-diagram, two isothermals pass characterised by

$$(\partial\mathrm{X}/\partial x)_{\mathrm{T}} = \partial^2\mathfrak{f}/\partial x^2 \pm f,$$

the upper sign referring exclusively to increasing, and the lower sign to decreasing values of x; and it is further *assumed* that for all realisable isothermal variations $(\partial\mathrm{X}/\partial x)_{\mathrm{T}} > 0$, which also gives $\partial^2\mathfrak{f}/\partial x^2 > 0$. Similarly through every point on an xT-diagram pass two iso-X lines given by

$$(\partial x/\partial\mathrm{T})_{\mathrm{X}} = -(\partial^2\mathfrak{f}/\partial x\partial\mathrm{T})/(\partial^2\mathfrak{f}/\partial x^2 \pm f),$$

wherein the upper and lower signs refer exclusively to increasing and decreasing values of x respectively; and it is further *assumed* that for all realisable iso-X variations $\lambda(\partial x/\partial\mathrm{T})_{\mathrm{X}} > 0$, and consequently $\lambda\partial^2\mathfrak{f}/\partial x\partial\mathrm{T} > 0$, where

$$\lambda(x, \mathrm{T}, \mathrm{X}) \equiv \partial\mathrm{E}/\partial x - \mathrm{X}$$

represents the heat added per unit alteration of x without change of T or X. The trend of the iso-X lines thus depends on the sign of λ.

For any finite variation we obtain by integration

$$\mathrm{X}_1 - \mathrm{X}_0 = (\partial\mathfrak{f}/\partial x)_1 - (\partial\mathfrak{f}/\partial x)_0 + \Sigma f\,|dx|,$$

and consequently a necessary condition for a closed cycle (*i. e.* with the same initial and final values of x, X, T) is

$$\Sigma f\,|dx| = 0:$$

all closed cycles must therefore cut the surface $f=0$ in an even number of points unless they lie wholly upon it. This surface is taken to represent the *natural* states of the system, which is characterised as of the First or Second Kind according as $\partial f/\partial x \gtrless 0$ when $f=0$; and the stability of systems of the first kind and the instability of those of the second, under physically constant temperature and external conditions, is demonstrated. The isothermal and iso-X transformations of these systems are then considered in detail, and the conditions of their satisfying Clausius' law $\int dQ/T < 0$ investigated, the special cases of pseudo-reversible processes entirely in the surface $f=0$, and of the actually reversible processes wherein x remains constant being separately treated.

In Part II. this theory is somewhat generalised for systems subjected to a uniform hydrostatic pressure, whose characterisation depends on a variable x in addition to p, v, T, and the isopiestic variations of such a system with temperature are discussed at length. The theory is then successfully applied to account in all respects for the peculiar behaviour of the different allotropic forms of sulphur, including the so-called mother-of-pearl variety, which Gernez has experimentally investigated. In this application any specimen of sulphur is assumed to be a mixture of two allotropic forms, one of which is soluble and the other insoluble in CS_2, and x is taken as the ratio of the mass in the latter form to that in the former.

In Part III. the theory is generalised for n normal variables, the laws of the variations of state produced by changes of temperature and of the external conditions are deduced, and general propositions are arrived at which in all points are similar to those that have long been known, from ordinary thermodynamics, to hold for systems which are not subject to permanent deformations. R. E. B.

1229. *Mechanical Theory of Heat.* **W. Stekloff.** (Comptes Rendus, 126. pp. 1022–1025, 1898.)—In a space D bounded by a surface S of definite curvature at every point, there is an infinity of positive numbers μ_s ($s=1, 2 \ldots$) and corresponding functions V_s satisfying the conditions

$$\frac{\partial^2 V_s}{\partial x^2}+\frac{\partial^2 V_s}{\partial y^2}+\frac{\partial^2 V_s}{\partial z^2}+\mu_s V_s = 0 \text{ within the space D,}$$

and

$$\frac{\partial V_s}{\partial n}+h V_s = 0 \text{ over the surface S,}$$

where n is the direction of the normal to S exteriorly, and h is a positive constant. If then f be a finite function, continuous within D with its derivatives of the first three orders and satisfying the equation of radiation over the surface S, f is developable in an absolutely convergent series proceeding according to the functions V_s. A. D.

1230. *Thermometry.* **C. Chree.** (Phil. Mag. 45. pp. 205–227, 299–325, 1898.)—An excellent discussion of the measurement of temperature by means of glass thermometers is here presented, in which are treated the zero-difficulties and lag due to the behaviour of glass, the methods of measurement with fixed and movable zeros, and the limits of accuracy of temperature-determination. In connection with these the subject of calibration is touched upon, and the special difficulties in the determination of the fixed points, and the allowances to be made for the emergent column and for external and internal pressure are discussed at length, as is also Welsh's method of graduation. This paper should be studied by those who rely upon glass thermometers for accuracy, and are not acquainted with Guillaume's 'Thermométrie de Précision,' or the work of the Bureau International, or of the Charlottenburg Reichsanstalt. R. E. B.

1231. *Dalton's Law for Mixed Gases.* **D. Berthelot.** (Comptes Rendus, 126. pp. 1703–1706, & pp. 1857–1858, 1898.) **Van der Waals.** (Comptes Rendus, 126. pp. 1856–1857, 1898.) **A. Leduc.** (Comptes Rendus, 126. p. 1859, 1898.)—Dalton's formulation of the law for gaseous mixtures was that the sum of the partial pressures is equal to the total pressure; this gives less accurate results than the alternative expression adopted by Sarrau, that the specific volume of a gaseous mixture is the (weighted) mean between the specific volumes of the components. The latter form is true for the "permanent" gases, and approximately for mixtures of two gases having nearly the same compressibility (*e.g.* N_2O and SO_2). D. Berthelot finds that very exact results may be obtained, starting from van der Waals' equation

$$\left(p + \frac{\alpha}{v^2}\right)(v - \beta) = R_1T$$

for each simple gas, and representing the behaviour of the mixture by an equation of the same form with the constants A, B, R, where

$$B = \frac{p\beta + q\beta'}{p+q},$$

$$A = \frac{p^2\alpha + 2pq\sqrt{\alpha\alpha'} + q^2\alpha'}{(p+q)^2},$$

$$R_1T = p + q,$$

p and q being the number of gram-molecules of the two gases respectively (p in the first equation above is the pressure).

Constants are given for the gases H_2, N_2, O_2, CO_2, N_2O, SO_2; and it is shown that the formulæ give results within the limit of error of experiment in various cases quoted, while Dalton's and Sarrau's experiments are very appreciably in error.

Van der Waals points out that the molecular theory leads to the above results, only with an undetermined coefficient, a_{12}, which Berthelot sets $= \sqrt{a_1 a_2}$: if it has this value, that is a purely empirical result.

Leduc mentions two cases in which Berthelot's formula gives less satisfactory results. R. A. L.

1232. *Compressibility of Gaseous Mixtures.* **E. H. Amagat.** (Comptes Rendus, 127. pp. 88–90, 1898.)—In 1880 the author had found that, up to 400 atmospheres, the volume of atmospheric air under any pressure is equal to the sum of the volumes of its constituents at the same pressure and temperature. The following table, calculated from his more recent experiments, shows that this law holds up to 3000 atmospheres at 0°. In the table (N+O) is the sum of the volumes occupied by 0·79 vol. of nitrogen and 0·21 vol. of oxygen (measured at 0° and 1 atmo.) when exposed separately to the pressures given in the first column, whilst A is the corresponding value for 1 vol. of air.

Pressure (atmos).	(N+O).	A.	Percentage difference.
100	0·009774	0·009730	+0·45
200	0·005063	0·005050	+0·26
300	0·003664	0·003658	+0·16
400	0·003034	0·003036	−0·06
500	0·002682	0·002680	+0·08
600	0·002453	0·002450	+0·12
700	0·002292	0·002291	+0·05
800	0·002174	0·002171	+0·14
900	0·002078	0·002075	+0·14
1000	0·002000	0·001999	+0·05
1200	0·001881	0·001883	−0·11
1400	0·001791	0·001792	−0·06
1600	0·001720	0·001721	−0·06
1800	0·001659	0·001662	−0·02
2000	0·001610	0·001613	−0·18
2200	0·001568	0·001570	−0·13
2400	0·001533	0·001534	−0·06
2600	0·001503	0·001500	+0·02
2800	0·001476	0·001469	+0·47
3000	0·001465	0·001455	+0·62

There are no data available by which the law may be tested for other gases near their critical points. T. E.

1233. *Reduction to normal degrees C. of Pt-temperatures on Dewar and Fleming's Thermometer "P_1."* **J. D. H. Dickson.** (Phil. Mag. 45. pp. 525–528, 1898.)—A table for every 5 *pt*-degrees from 100° to −283° is calculated from the formulæ

$$R = \cdot 010975\,(pt + 283\cdot 0),$$

$$(R + 20\cdot 529023)^2 = \cdot 53270015\,(t + 1048\cdot 4396).$$

[This is equivalent to $t = 0\cdot 000226113(pt + 4306\cdot 85)(pt + 0\cdot 21)$.]

R. E. B.

1234. *Specific Heat of Air at Constant Pressure.* **A. Leduc.** (Comptes Rendus, 126. pp. 1860–1861, 1898.)—The author has discovered an error in Regnault's measurement. Regnault found that the expansion of the air in his experiments, in passing from the heater to the calorimeter, absorbed $\frac{1}{180}$ of the heat given out to the calorimeter; yet he ignored this quantity in recording his results. If it be taken into account, the specific heat becomes 0·239, in exact accordance with the result found by E. Wiedemann.

R. A. L.

1235. *Spheroidal State.* **J. Stark.** (Annal. Phys. Chem. 65. 2. pp. 306–310, 1898.)—The author considers fully in this paper the conditions present in a drop of liquid when in the spheroidal state on a hot plate, and explains by means of these all the phenomena which have yet been noticed in this connection. The want of complete electrical insulation between the drop and the plate he accounts for by oscillations of the drop, and the presence of these oscillations he verifies by placing a telephone in an electric circuit containing a battery and the gas film between the drop and the plate. The influence of different liquids and different temperatures on the noise in the telephone is noted in the paper. The well-known vortex motion noted in the drops he attributes to variation of surface-tension owing to differences of temperature at different parts of the drop. The bottom surface being hottest, has least surface-tension and therefore tends to extend. This causes a circulatory motion of the liquid surface, from the centre outwards in the bottom surface and towards the centre in the upper surface.

J. B. H.

ELECTRICITY.

1236. *Irreversible Radiation Phenomena.* **L. Boltzmann.** (Berlin. Akad. Sitzber. 12. pp. 182–187, 1898.)—Planck in his communication, 16th December, 1897, defined the reverse of a given process or course as follows, viz., the time t before the reversal in the original course is *the corresponding time* to t after the reversal in the reversed course. Then the electric forces have at corresponding times the same sign and value in the reversed and in the original course. The magnetic forces, with the same absolute value, have at any time t in the reversed course the opposite sign to that which they had at the corresponding time in the original course. Boltzmann accepts that definition.

Planck considers a hollow sphere in which a system of electric waves is set up, and there is an electric resonator at the centre. The motion is defined by the equation

$$F = \frac{\phi\left(t - \frac{r}{c}\right) + f\left(t - \frac{r}{c}\right) - \phi\left(t + \frac{r}{c}\right)}{r},$$

r being the distance of any point from the centre. The term $f\left(t - \frac{r}{c}\right)$ relates to the electric moment of the resonator.

If the subscript u refer to the reversed motion, then, if it be a true reversal, we must have

$$\phi_u\left(t - \frac{r}{c}\right) + f_u\left(t - \frac{r}{c}\right) - \phi_u\left(t + \frac{r}{c}\right)$$
$$= \phi\left(-t - \frac{r}{c}\right) + f\left(-t - \frac{r}{c}\right) - \phi\left(-t - \frac{r}{c}\right);$$

and in order that this may be true for all values of r and c we require

$$\phi_u(\omega) = -\phi(-\omega) - f(-\omega)$$

for any whatever argument ω.

Planck now defines two motions, viz.:—

A. $$f(t) = -2D \sin(k\pi) \sin\left(\frac{2k\pi t}{T} + \pi k - \theta\right),$$
$$\phi(t) = D \cos\left(\frac{2k\pi t}{T} - \theta\right);$$

B. $$f_u(t) = 2D \sin(k\pi) \sin\left(\frac{2k\pi t}{T} - \pi k + \theta\right),$$
$$\phi_u(t) = -D \cos\left(\frac{2k\pi t}{T} + \theta\right),$$

of which B is, according to Planck, the reversal of A. But the values of $f_u(t)$ and $\phi_u(t)$ given by B do not satisfy equation (*b*), and therefore B is not the true reversal of A. Now B does not satisfy Planck's necessary conditions, and is therefore, Planck argues, an impossible motion.

According to Planck, if the motion be reversed, the reversed motion does not satisfy the conditions, and is therefore impossible. According to Boltzmann, that is because the motion B which Planck takes for the reversed motion is not accurately such. If instead of Planck's equations for the second motion we use the complete equations, it satisfies all necessary conditions.

[For previous papers, see Abstracts Nos. 630 and 631, and Phys. Soc. Abstracts, No. 651, 1897.] S. H. B.

1237. *Validity of Maxwell's Equations.* **A. Scheye.** (Zeitschr. Phys. Chem. 26. pp. 159–160, 1898.)—In this note the author defends Maxwell's Electromagnetic Equations against the attack made upon them by Wedell-Wedellsborg in an article bearing the title of this abstract, and published in the Zeitschr. Phys. Chem. 24. 367 (1897). E. H. B.

1238. *Theory of Galvanism and Heat.* **E. Riecke.** (Göttingen Nachrichten, 1. pp. 48–70, 1898.)—The author expresses the view that the older—or pre-Maxwell—Theory of Electricity, due to Coulomb, Ampère, and W. Weber, is likely to acquire renewed importance in the treatment of electrolysis and the theory of ions; and he refers to the writings of Christiansen, Giese, and H. A. Lorenz, whose theory is based on the ions. In the present paper the writer, following W. Weber, holds that the conduction of electricity and of heat in metals takes place in a way not different in principle from electrolysis. In the space between the ponderable molecules are moving not only positive but also negative electric particles.

1. Considering first conduction of heat, he supposes a cylinder of metal parallel to the z axis. The temperature increases with z. The law of conduction of heat is then

$$\mathfrak{W} = -k\frac{dT}{dz}.$$

This is accompanied by a galvanic current, whose strength in electromagnetic measure is

$$\begin{aligned}\gamma &= -\omega k\frac{dT}{dz}\\ &= -\omega\mathfrak{W}.\end{aligned}$$

The factor ω is defined as the "Mitführungszahl" for electricity, which I propose to translate "coefficient of the attendant current."

2. He treats the galvanic current as the principal one, and finds an "attendant current" of heat.

In the remaining articles he treats on the same principle:—

3. The relation between the constants of conduction of heat and of electricity.
4. The theory of the attendant current in thermoelectrity.
5. The Peltier effect.
6. The Thomson effect.
7. The thermoelectric circuit and the second law of thermodynamics.
8. The process which goes on at the junction of two metals.
9. The more general formulæ of thermoelectricity.
10. Galvano-magnetic action.
10. Thermo-magnetic action.
12. Simplification of the formulæ for galvano-magnetic and thermo-magnetic action.

S. H. B.

1239. *Energy of an Electrified System.* **H. Pellat** and **P. Sacerdote.** (Comptes Rendus, 126. pp. 817–820, 1898.)—A discussion is given of the excess of energy (considered as seated in the dielectric) of a system of conductors and dielectrics, due to their electrification. The dielectric is regarded as homogeneous and isotropic, and the conductors and dielectric are supposed to have the same expansion. The result reached is that the excess of energy

$$=\int\left(1+\lambda T+\frac{T}{K}\frac{\partial K}{\partial T}\right)\frac{K\phi^2}{8\pi}\,.\,dv,$$

where λ is the linear coefficient of expansion of the dielectric, T the temperature, K the specific inductive capacity, and ϕ the intensity of the electric field in the volume dv of the dielectric. The energy per unit volume acquired by the dielectric owing to the charging of the system, the temperature remaining the same, is not $\frac{K\phi^2}{8\pi}$, but $\left(1+\lambda T+\frac{T}{K}\frac{\partial K}{\partial T}\right)\frac{K\phi^2}{8\pi}$.

J. J. S.

1240. *Imaginary Electrical Quantities.* **H. Pellat.** (Écl. Électr. 15. pp. 221–228, 1898.)—In this treatment of the application of the complex variable to alternating-current problems the author assumes (1) that all impressed E.M.F.'s have the same periodic time, and (2) that the coefficients of self-induction are constant. It is also assumed that all the alternating electrical quantities may be represented by a sine curve. It is found that for a resistance R, capacity C, and self-induction L in series, the charge, Q, on the condenser is given by

$$L\frac{d^2Q}{dt^2}+R\frac{dQ}{dt}+\frac{Q}{C}=(Ee^{\phi k}+ue^{\psi k})e^{kpt},$$

where u is the maximum value of the potential difference applied between the terminals of the circuit, and E the maximum value of any internal E.M.F., $k = \sqrt{-1}$, and $p = 2\pi n$, n being the frequency. The solution of the above equation gives

$$Q = \frac{Ee^{k(pt+\phi)} + ue^{k(pt+\psi)}}{-Lp^2 + \frac{1}{C} + kpR},$$

whence the current i is given by

$$i = \frac{dQ}{dt} = \frac{kp\{Ee^{k(pt+\phi)} + ue^{k(pt+\psi)}\}}{-Lp^2 + \frac{1}{C} + kpR}$$

$$= \frac{Ee^{k(pt+\phi)} + ue^{k(pt+\psi)}}{\rho},$$

where

$$\rho = R + k\left(Lp - \frac{1}{Cp}\right);$$

ρ is the impedance of the circuit, and when multiplied by the current i gives the E.M.F.

The author then proceeds to deduce Kirchhoff's laws as applied to alternating-current circuits, and finds that at a junction in a network of conductors

$$\Sigma i = 0,$$

and round any closed circuit

$$\Sigma i\rho = E,$$

where E is the total E.M.F. in the circuit.

The paper contains also some interesting applications of the method of the complex variable. W. G. R.

1241. *Rotation of Insulators in Magnetic Field.* **H. Benndorf.** (Wien. Akad. Sitzber. 106. pp. 1075–1084, 1897.)—After referring to Duane and Stewart's investigations on this subject [see Phys. Soc. Abstracts, No. 665, 1896, and No. 615, 1897], the author challenges a conclusion arrived at in a recent paper by A. Campetti, in which the latter states that by using a magnetic field of sufficient intensity the energy of electric polarisation may be so far increased as to become comparable with the kinetic energy of the rotating insulator, and that the damping observed by Duane may be ascribed to this fact. The author states that he has investigated the problem from a theoretical standpoint, and arrived at an expression for the electric energy which is identical with that obtained by Campetti. Hence he concludes that the latter has either not attempted to calculate the field-intensity required to bring about the result stated, or else has mixed up the electrostatic and electromagnetic systems of units in working out the numerical result. Campetti's theoretical investigation is next reproduced, with slight modifications. It is shown that when a sphere of radius a and dielectric constant K is rotating with angular velocity ω about an axis normal to a uniform magnetic field of intensity H, the energy of electric polarisation in the sphere is

$$W = KH^2\omega^2a^4(1+4R^2)/60,$$

R being a proper fraction. The kinetic energy of the sphere is

$$U = \tfrac{4}{15}\pi\omega^2a^5\rho,$$

ρ being the density. Assuming that R reaches its limiting value of 1, and that $H = 10{,}000$, $\rho = 1$, we have, if K be, as usual, measured in electrostatic units,

$$W/U = \frac{K}{9.10^{13}}.$$

This proves the fallacy of Campetti's conclusion, and shows that the damping observed by Duane can never be accounted for by dielectric hysteresis. A. H.

1242. *Electric Discharge in a Magnetic Field.* **A. Broca.** (Comptes Rendus, 126. pp. 823–826, 1898.)—A further description is given of the author's experiments on discharges in tubes containing rarefied gases in intense magnetic fields. He suggests that phenomena occur analogous to that of Zeeman, and considers that the hypothesis of vibrating ions furnishes an explanation which though not a necessary is a sufficient means of coordinating the facts relative to the luminous emission of incandescent gases and those relative to the electric discharge in gaseous media. J. J. S.

1243. *High-Frequency Gas Discharges.* **H. Ebert.** (Annal. Phys. Chem. 65. 4. pp. 761–788, 1898.)—The discharge in a vacuum-tube consists of two distinct parts. One of them is an ordinary conducting discharge, with development of Joulean heat; the other is the partial or complete breaking-down of a dielectric capacity. When high-frequency currents are employed, the latter is more emphasised in comparison with the former. Such high-frequency currents may be generated direct by an alternator, as originally employed by Tesla. The author uses a motor-alternator. The alternate-current obtained is transformed to a high potential by a hedgehog transformer. The high-potential alternate current is measured by a heated-wire ammeter, and the effective E.M.F. is measured by an aluminium plate suspended by a quartz fibre between two plates connected with the points studied. In most of the experiments, the frequency was 1000 per second, and the E.M.F. varied from 700 to 3000 volts. The discharge had a perfectly symmetrical aspect; the three kathode layers immediately adjoined both electrodes, and the red anode light lay between them. All the luminous phenomena were very intense. Analysis by means of a revolving mirror yielded the following facts:—The appearance is due to two discharges in opposite directions, which are superposed. Each discharge is complete, there being no partial discharges. In the mirror the single discharges are divided by perfectly dark though very narrow intervals, except at very low pressures. At 2·5 mm. pressure, with 112 watts for the continuous current, 16·5 watts for the low-pressure, and 12·8 watts for the high-pressure alternate current, and with an effective E.M.F. of 958 volts, the discharge-tube consumed 9·2 watts. With longer tubes the proportion was more favourable. E. E. F.

1244. *Dark Kathode Space.* **A. Wehnelt.** (Annal. Phys. Chem. 65. 3. pp. 511–542, 1898.)—Those parts of the discharge-tube at which the dark kathode-space usually appears offer a great resistance to the development of the positive discharge. To investigate the nature of the discharge when produced within the dark space itself, the author utilises the power of rapidly damped electric oscillations to affect a coherer, or to excite slightly damped electric oscillations in a Lecher wire-system. He also uses discharge-tubes in which, by means of the barometer contrivance, the electrodes can be mutually approached to any desired extent. He finds that at the higher pressures no waves are sent out which affect the coherer, but that when the dark space envelopes the anode a totally different form of discharge sets in, which gives rise to strong electric waves, perceptible at a distance of 5 m. This result happens both when the dark space is enlarged by exhaustion so as to envelope the anode, and when the anode is mechanically introduced into the dark space. The secondary dark spaces formed at the walls near the kathode also offer a resistance to the discharge proceeding from the anode. The results are the same whether the discharge is produced by an influence-machine or by a battery of accumulators giving 2000 volts. When the anode projects into the dark space, the discharge potential rises, and the anode light turns back until it reaches the glow light outside the dark space. At the same time the potential gradient in the dark space increases. X-rays are due to the presence of rapidly-damped disruptive discharges, and are probably formed by a sudden impact of charged particles upon a solid body. E. E. F.

1245. *Kathode Rays parallel to Electric Force.* **P. Lenard.** (Annal. Phys. Chem. 65. 3. pp. 504–510, 1898.)—The extent to which a kathode beam is deflected by a given electric or magnetic field has hitherto been assumed to be invariable as long as the origin of the beam remained the same. But the emission theory of kathode rays suggests a variation which may be brought about by sending the beam along the lines of force extending between the two plates of a condenser, as may be done by perforating the condenser plates. Such a variation may be actually placed in evidence. The author uses as a generator the vacuum-tube with aluminium "window" used in his former experiments. An air-condenser, consisting of two parallel plates perforated in the centre, is mounted in an exhausted tube attached to the window. A kathode beam emerges from the window and passes through in the direction of the lines of electric force. It is finally caught on a fluorescent screen, on which its deflection is indicated by the shifting of a spot of light. No deflection is produced by charging the perforated condenser. But when the plate next the window is charged positively, the magnetic deflection of the beam is increased. This means that the transmission of the kathode rays through an electrostatic field is in the direction of the lines of force. In one case quoted the sparking-distance in the discharge-tube was 2·8 cm., the difference of potential between the condenser-plates was 291×10^{10} C.G.S. electromagnetic units, the original velocity of the rays $0{\cdot}70 \times 10^{10}$ cm./sec., and the final velocity $0{\cdot}35 \times 10^{10}$. Hence the velocity is reduced to one-half the original amount. The most remarkable circumstance is that the electrostatic field should modify the velocity of something which is already moving at a rate comparable with the velocity of light. E. E. F.

1246. *Measurement of Electric Waves by Interference.* **P. Drude.** (Annal. Phys. Chem. 65. 3. pp. 481–498, 1898.)—V. von Lang's method of measuring the length of electric waves by sending them through the two unequal branches of a Quincke tube, and noting their interference, is unsuitable for the purpose, since the interference-tube itself contributes to determine the wave-length. As a general rule, it may be said that the wave-length indicated by the interference-tube is double the diameter of the tube itself. In the experiments of which this is the result, a coherer was employed which consisted of small iron screws, thus giving graduated reactions, instead of the highly sensitive but sudden reaction of the Marconi pattern. Instead of a tapping device, the coherer was lifted by means of a thread and allowed to drop on to its wooden support to restore the primitive resistance. E. E. F.

1247. *Absorption of Electric Waves by Water.* **P. Drude.** (Annal. Phys. Chem. 65. 3. pp. 499–503, 1898.)—The absorption by water is difficult to establish owing to the large amount of reflection at the surface. The author employs a device in which the thickness of the water layer may be varied without changing the reflection. He inserts plates of glass of different thicknesses in a trough of water with glass walls. With waves 9 cm. long it is found that the reaction of the coherer decreases with the thickness, whereas waves 60 cm. long are not perceptibly affected. The decrease might be due also to an influence of the thickness of water upon its reflective power, as in the case of Newton's rings. But this is rendered improbable by the fact that the transmission decreases continuously. The apparent absorption is greatly altered by the presence of metallic bodies such as mirrors or tubes in the neighbourhood of the exciter. These bodies affect the wave-length. R. E. F.

1248. *Electrical Oscillations in Wires.* **H. C. Pocklington.** (Cambridge Phil. Soc. Proc. 9. 7. pp. 324–332, 1898.)—This paper deals with electrical oscillations about perfectly conducting wires of circular cross-section. The first step is to find an expression for the electrical forces which satisfies the general differential equations and is infinite at the wire. This expression represents the forces due to an arbitrary distribution of infinitesimal Hertzian oscillators with their axes along the axis of the wire. The solution is completed by finding the form of the arbitrary function from the condition that the electric force must be normal to the wire at its surface. The problem is worked out in detail for the case of a circular wire, the period of the vibration and the damping being calculated for the case of the fundamental vibration of a thin wire. The resonance of a circular conductor is discussed. It is found that when the resonator is correctly tuned, the induced current is independent of the cross-section of the wire. The case of a helical wire is next considered. When the period of an oscillation which is being propagated along the wire is not great, two velocities of propagation are possible—one with velocity (measured along the wire) equal to that of light, the other with a greater velocity. If the period is greater than a certain finite value, the former velocity only is possible. If, however, the period is very great, the velocity of propagation along the wire is greater than that of light. In the limit the velocity along the axis of the helix is equal to the velocity of light. These results agree with Hertz's experiments on helical wires. AUTHOR.

1249. *Insulation and Conduction.* **R. A. Fessenden.** (Amer. Instit. Elect. Engin. 15. pp. 187–204, 1898.)—*Part I.* For insulation it is necessary to have—

(1) Dielectric strength; (2) Resistance.

The one important for power-transmitting, the other for conveying signals. Conduction is considered under four heads:—Convection, conduction in solids, in fluids, and in gases.

A. Convection supposes a small particle moving from one electrode to the other, and conveying the charge like a pith-ball swinging between electrified knobs.

It is remarked that impurities in the oil are apt to group themselves along the lines of the highest slope of potential, like iron filings on a magnet. For a convective current to take place the radius of the particles carrying the discharge must be a large fraction compared to the radius of the charged conductor.

Convection may be stopped:—

(1) By using a viscous oil;
(2) By interposing dry cellulose;
(3) By dissolving a solid non-dissociating substance of the oil so as to obtain a gelatinous mass, for example paraffin (which has an additional value from its high specific heat of liquefaction).

The effect of points in promoting convection is two-fold:—

(1) Repulsive force varies as the square of the density, which is high at a point: and
(2) Particles will not take the charge away unless their radius be large compared to that of the charged conductor.

B. Conduction in solids is not yet quite determined to be convection, though the conductivities of metals are in proportion to the quantity

$$\sqrt{\frac{\text{elasticity}}{\text{density}}} + \text{valency}.$$

This formula is analogous to that for the velocity of sound in a body, thus corresponding to the fact that in the convective discharge electricity moves with the same velocity as that with which the ions move. This would probably have been observed long ago had the writer's discovery, as expressed in the following formula, been known:

$$\text{Young's modulus equals } \frac{78 \times 10^{12}}{(\text{atom. vol.})^2};$$

whence the velocity of sound in wires cms. per sec. equals

$$\frac{883 \times 10^4}{\text{atom. vol.} \times \sqrt{\text{density}}};$$

and the electric resistivity approximately equals

$$45 \times 10^{-9} \times \text{atom. vol.} \times \sqrt{\text{density}} \times \text{valency}.$$

It would appear, then, that the dielectric strain is propagated with the velocity of light $\sqrt{K\mu}$; whereas the actual electricity in the wire moves with that of sound proportional to $\sqrt{\frac{K}{\mu}}$.

The metals are arranged in a Newland's chart to compare their mechanical and electrical properties. The chart is modified to show that metalloids tend to polymerisation from their higher valencies.

The author is inclined to believe that increased resistance accompanies polymerisation, and that polymerisation varies as the valency, in fact anything which tends to give molecular complexity tends to give high resistance. Hence we see that alloys are higher in resistance than the average of their components. It is also hoped to prove that the conductivities are in the same ratio as the velocities of very short sound waves, from the consideration that when the period of sound-waves coincides with that of the molecules it is a heat-wave, and that heat is transmitted with the velocity of short sound-waves, but with a large logarithmic decrement.

C. *Conductivity of Fluids.*—The author prefers to state the law of osmosis as follows:—Dissolved substances give an osmotic suction per square cm. which is equal numerically to the kinetic pressure which the substance would have if it were turned into a gas at the same temperature and volume as the solution. It is found that only those salts which are dissociated when in solution can conduct electricity. Hence the conductivity of solution depends on—

(1) The attraction of the molecules of the solvent for the ions of the solute;
(2) How fast the ions move;
(3) The valency of the ions.

D. *Conductivity of Gases.*—This is thought to be electrolytic, though points are given in favour of convection.

[For the second part of this paper see Abstract No. 1273.]

M. O'G.

1250. *Conductivity of Thin Sheets of Silver.* **G. Vincent.** (Comptes Rendus, 126. pp. 820–823, 1898.)—The experiments were carried out with thin layers of silver deposited chemically on carefully cleaned plates of glass. The thickness of each sheet was determined by Wiener's method, which depends on the transformation of silver into iodide. The limits of thickness in the experiments were 38 μ and 170 μ. On taking as abscissæ the thickness, e, of the silver and as ordinates the conductivity $\frac{1}{\rho}$, a straight line is obtained when the thickness $e=50\ \mu$ or above. This straight line passes below the origin and cuts the axis of abscissæ at the point $e=26\ \mu$ about. For thicknesses less than 50 μ the curve drops below the straight line. The function $\frac{1}{\rho}$ for thicknesses above 50 μ is of the form $-A+Be$. This implies the existence of a homogeneous layer which is comprised between two superficial layers of less conductivity at the contact of air and glass. As long as the intermediate homogeneous layer exists, the points in the diagram fall on the straight line. They depart from it when the total thickness of the layer becomes equal or inferior to the sum of the "thicknesses of passage." Hence the sum of the thicknesses of passage is about 50 μ, a value which is nearly that obtained by Quincke in his capillary experiments. Viewed under the microscope the layers used, even the thinnest, were absolutely continuous. The equation of the straight line deduced from the mean of the results is

$$\frac{1}{\rho} = \frac{\epsilon - 26}{24{\cdot}2}.$$

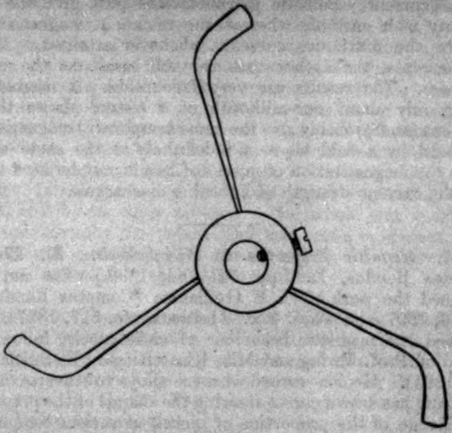
The value deduced for the specific resistance at 0° of a sheet of silver sufficiently thick for the influence of the superficial layers to be neglected is 1·45 about; taking as unity Matthiessen's value for the specific resistance of ordinary annealed silver. J. J. S.

1251. *Resistance-box for Wheatstone-bridge Ratio-arms.* **O. Schöne.** (Zeitschr. Instrumentenk. 18. pp. 133–135, 1898.)—The author describes a new arrangement of resistances for the ratio-arms, enabling the resistances to be interchanged and their accuracy thereby tested. Eight brass pieces are fixed to two brass strips on the ebonite cover of the box, each piece being provided with two plug connections, one to each strip. These strips are the end terminals; the middle terminal is a third strip inside the box, between which and each brass piece are connected eight resistances, two each of 1, 10, 100, and 1000 ohms. Thus either of the 1-ohm coils, for instance, can be connected to either strip, and any ratio can be obtained in four different ways. Further advantages claimed for this arrangement are that only two plugs are required, whose contact-resistances, being always in circuit, can be allowed for in the adjustment of the coils; and that, by means of a third plug connecting two resistances in parallel, ratios of 1 : 5 and 1 : 20 may be obtained. G. H. Ba.

1252. *Condenser in Induction-coil.* **T. Mizuno.** (Phil. Mag. 45. pp. 447–454, 1898.)—The use of a condenser in the primary circuit of an induction-coil, in order to increase the efficiency (Fizeau) is well known but not well explained. There is a special amount of capacity required for each value of the primary current in order to make maximum secondary spark-lengths, and it is greater the stronger the primary current. On increasing the capacity the spark-length at first rapidly rises, then more slowly falls off. A. D.

1253. *Induction-coil Contact-breakers.* **M. Izarn.** (Journ. de Physique, 7. pp. 342–343, 1898.)—When the contact-breaker is not an independent one, the author finds that the results are more regular if the massive column is not rigidly but to a certain extent elastically fixed to the base-board. He mounts it on a strip of brass 6 cm. × 3 cm. × 1 mm., fixed to the base-board only at its two ends. The screw regulating the frequency must fit tight enough not to slip. A. D.

1254. *Improved Mercury Interrupter.* **H. Hauswaldt.** (Annal. Phys. Chem. 65. 2. pp. 479–480, 1898.)—The shape of the three-rayed star wheel used by Hofmeister is modified, as shown in the figure. The wheel is made of silver, with narrow blades, which enter and leave the mercury noiselessly. E. E. F.



1255. *Electrolytic Thermopiles.* **W. Duane.** (Annal. Phys. Chem. 65. 2. pp. 374–402, 1898.)—The author deals with thermopiles in which both electrodes are kept at the same temperature, and in which, consequently, the thermoelectric forces are developed in the electrolytes themselves. A second electrolyte is inserted between the two portions of the first which adjoin the electrodes, and the two liquid junctions are kept at different temperatures. The author used none but dilute solutions, so as to remain within the assumptions of Nernst's theory. In one set of experiments the two solutions were of the same electrolyte but of different concentrations; in the other they were of different electrolytes but of the same concentration. In both cases the results obtained were in close agreement with Nernst's theory, within the somewhat wide limits of experimental error. The middle solution was contained in a bulb with two arms bent downwards and dipping into the electrode solutions, the ends of the tubes turning up and being provided with small holes, through which the liquids came into contact. E. E. F.

1256. *Currents measured by Magnetisation.* **F. Pockels.** (Annal. Phys. Chem. 65. 2. pp. 458–475, 1898.)—The author endeavours to determine the maximum discharge-current by the remanent magnetism induced in magnetic substances acted upon by the current. Ballistic galvanometers only give the average intensity of a current, whereas the remanent magnetism would indicate the maximum current, whenever attained. To avoid eddy-currents, the author uses bars of basalt as the magnetic substance. The results are very favourable. A magnetic field lasting only about one-millionth of a second shows the same remanent (and probably also the same temporary) magnetisation as is induced by a field kept up indefinitely at the same strength. Hence the magnetisation of pieces of basalt may be used to determine the current strength of lightning discharges. E. E. F.

1257. *Magnetic Properties of Nickel-Steels.* **E. Dumont.** (Comptes Rendus, 126. pp. 741–744, 1898.)—The author has continued the work of C. E. Guillaume (Comptes Rendus, 124. p. 1515, 1897, and Phys. Soc. Abstracts, No. 517, 1897), and has examined the magnetic behaviour of nickel-steels, following the method of Prof. Ewing and Miss Klaasen (see 'Electrician,' May 15th, 1891). He has caused various alloys to traverse magnetic cycles, and has drawn curves showing the change of the permeability with change of the proportion of nickel, at various temperatures, and with various strengths of field. He finds that at an equal distance from the point of total loss of magnetism, all the reversible alloys have the same magnetic permeability. Moreover, at every temperature the permeability of alloys containing 27 to 44 per cent. of nickel increases with the proportion of nickel.

J. J. S.

ELECTRO-CHEMISTRY AND CHEMICAL PHYSICS.

1258. *Change of Weight with Change of Temperature.* **P. R. Heyl.** (Frank. Instit. Journ. 145. pp. 385–387, 1898.)—The accepted explanation of the familiar fact that a hot body appears to weigh less on a balance than a cold one, is that the convection air-currents raise the scale. Certain experiments of Heyl having led him to suspect that there might be a true loss of weight in minute proportions, he has devised an apparatus (illustrated) to avoid convection. A sealed tube with a central constriction had, in the upper part, a short stick of potash, in the lower 50 °/₀ sulphuric acid. It was protected by a thin jacket containing solid acetic acid, and by an outer air-case. The whole was weighed, then inverted, whereby the potash and acid came in contact and internal heat was generated, then again weighed. No appreciable difference was recorded by the balance used. S. R.

1259. *Acetylene Compound with Cuprous Oxychloride.* **R. Chavastelon.** (Comptes Rendus, 127. pp. 68–69, 1898.)—The compound $C_2H_2 . Cu_2Cl_2$ is slowly decomposed into hydrochloric acid, acetylene, and a violet-coloured substance having the composition $C_2H_2 . Cu_2Cl_2 . Cu_2O$. The decomposition is incomplete in presence of hydrochloric acid. T. E.

1260. *Decomposition of Nitric Acid by Heat.* **M. Berthelot.** (Comptes Rendus, 127. pp. 83–88, 1898.)—As a preliminary to the investigation of the action of light on nitric acid, the decomposition of this substance by heat alone is studied. Pure nitric acid decomposes at 100° into oxygen, water, and nitric peroxide with absorption of a small amount of heat. The change is not reversible under the conditions in which the decomposition takes place. T. E.

1261. *Equilibrium in Mixtures of Water, Ether, and Succinonitrile.* **F. A. H. Schreinemakers.** (Zeitschr. Phys. Chem. 25. pp. 543–567, 1898.)—The results of a discussion of this system, which is such that *three* liquid layers may exist in equilibrium, are here given; a fuller account will follow later. But even the results here presented are too intricate to satisfactorily abstract. R. E. B.

1262. *Equilibrium of the System—Water, Benzoic Acid, Succinonitrile.* **F. A. H. Schreinemakers.** (Zeitschr. Phys. Chem. 26. pp. 237–254, 1898.)—In systems of three components different cases occur according to the behaviour of the components taken in pairs: (1) Each pair may form only homogeneous solutions; (2) two of the pairs may form only homogeneous solutions, while the third pair may form two liquid layers; (3) two pairs may each form two liquid layers, the third pair alone forming only homogeneous solutions; (4) all three pairs may each form two liquid layers. The author has already experimentally investigated case (2) which occurs with sodium chloride, water, and succino-nitrile, of which the last two are the singular pair; and water, ether, and succino-nitrile (see Abstract, No. 1261) are an example of case (4); in the present paper an instance of case (3) is treated. But of case (3) there are two varieties: either (α) the layer-formation with both pairs may occur simultaneously, as with water, alcohol, and succino-nitrile (to which a later paper will be devoted); or (β) each pair may form its layers only at temperatures at which the other pair forms homogeneous solutions. The latter is the variety presented by the substances in this paper, water and the nitrile forming two liquid phases only at temperatures between 18°·5 and 56°·5 C., and the two liquid phases given by water and benzoic acid occurring only between 95° and 115°·5 C.; while benzoic acid and the nitrile form homogeneous solutions only. For details we must refer to the memoir itself. R. E. B.

1263. *Number of Nuclei in Supercooled Liquids.* **G. Tammann.** (Zeitschr. Phys. Chem. 25. pp. 441–479, 1898.)—Like the crystallisation-velocity, the number of nuclei spontaneously formed in a liquid varies with the degree of supercooling; the two factors completely determine the rate of solidification. The number is proportional to the volume of the liquid and the time of exposure, though in small volumes and times the proportionality is masked by the element of chance. The number is very sensitive to the purity of the sample and is altered in both directions by additions, soluble or insoluble; these do not, however, appreciably alter the position on the temperature curve of the maximum, which is very sharp, and lies in the region where the crystallisation-velocity falls off with reduced temperature. A large number of organic substances (59 out of 150 investigated, and fully described as to behaviour on solidifying) can be obtained as glass (liquids of high viscosity) by rapidly cooling to a temperature at which nuclei are no longer formed at an appreciable rate. Two or more polymorphic forms are frequently formed at the same temperature, and the number of nuclei of one can often be reduced apart from the others, by slight additions; the maximum for the more stable form often, but not always, lies at a lower temperature than that of the less stable form. A desired form might be obtained with greater certainty by sowing the liquid with a nucleus of this form at a temperature too low for the spontaneous appearance of nuclei.

The substances investigated quantitatively are piperidin and betol, and the method is to seal them in long capillary tubes, melt at a fixed temperature, and bring rapidly to the temperature of observation by plunging in a water-bath, and subsequently, where necessary, developing the nuclei formed at a temperature at which the velocity of crystallisation is appreciable, and that of nuclei-formation negligible. In some cases the tubes were first rapidly cooled below the maximum of nuclei-formation, and then raised to the temperature of observation: the various methods showed by their agreement the reliability of the result. B. B. T.

1264. *Electrolytic Solution of Platinum and Gold.* **M. Margules.** (Annal. Phys. Chem. 65. 3. pp. 629–634, 1898.)—Platinum and gold may be dissolved without aqua regia by sending the current from an induction-coil through an electrolytic cell containing those metals as electrodes. A small U-tube is used as a cell, and in about three minutes the liquid about a platinum anode turns perceptibly yellow. In an hour, about 1 mgr. of platinum is dissolved. At least three Daniells must be used to feed the coil. Gold is similarly dissolved; but all its solutions are very sensitive to light. The yellow sulphate rapidly precipitates gold under the influence of daylight. The solution in caustic potash, whatever its nature may be, is somewhat more stable, and may be used for gilding. The author expects to be able to dissolve carbon in a similar way, and thus produce organic compounds. E. E. F.

1265. *Quantitative Electrolytic Separation of the Halogens.* **H. Specketer.** (Zeitschr. Elektrochem. 4. pp. 539–542, 1898.) —Electrolytic separations depending on regulation of the E.M.F. have hitherto been applied to the metals only; the principle is here made use of for the separation of chlorine, bromine, and iodine. Attempts to effect this by successive liberation of the free halogens from solutions of their hydrogen acids were unsuccessful; but satisfactory results are obtained by converting them into the silver halides by electrolysis of the potassium halides in normal sulphuric-acid solution between a silver anode and a platinum kathode. For the separation of iodine an E.M.F. of 0·13 volt should be employed, and for bromine 0·33 volt; the chloride remaining in the solution is best determined volumetrically by the usual methods. The silver salts are precipitated in a dense coherent form, easily washed, dried and weighed. During the electrolysis the oxygen of the air must be carefully excluded, otherwise erroneous results are obtained, and the solution is therefore placed in a narrow cylindrical vessel into which a current of hydrogen is passed. It is also most important that the concentration of the acid in the electrolytic cell and the E.M.F. employed should be maintained at a constant definite value, and that the anode should consist of perfectly pure silver wire. J. W.

1266. *Electrolytic Conductivity of Dilute Solutions at Temperatures up to* 100°. **R. Schaller.** (Zeitschr. Phys. Chem. 25. pp. 497–524, 1898.)—To avoid the solubility of glass at higher temperatures platinum apparatus is used. By placing this within a kind of diving-bell in a water-bath the temperature of the solution is maintained constant, and evaporation prevented. Small electrodes (platinised by means of a solution containing lead acetate) are used, since large ones give rise to considerable errors owing to absorption of the dissolved substance. The author subsequently finds that vessels of normal Jena glass have little or no influence on the results obtained with solutions of salts or acids at 100°. The increase of the molecular conductivity of sodium and potassium chlorides and nitrates (1 molecule in 256 to 1024 litres) between 25° and 99° is nearly proportional to the temperature; the temperature coefficient increasing slightly with rising temperature, whilst for hydrochloric acid it diminishes. The sodium salts of a number of organic acids, examined under the same conditions, behave in the same way as the neutral salts above mentioned. Their temperature coefficients are practically the same (0·0264 to 0·0268 at 62°), and somewhat greater than those of the inorganic salts, in accordance with the rule that the electrolyte with the more mobile ions has the smaller temperature coefficient. Solutions of the free organic acids are only partially ionised, and in all cases the ionisation diminishes at the higher temperatures. In some cases this diminution is so large that the conductivity of the solution decreases at higher temperatures, notwithstanding the greater mobility of the ions. The heats of dissociation of all the acids examined diminish with rising temperature. T. E.

1267. *Sulphating of Negatives in Lead Accumulators.* **L. Jumau.** (Écl. Électr. 16. pp. 133–136, 1898.)—The evolution of hydrogen and formation of lead sulphate at the negative plates while the element is at rest is due to two principal causes—(1) the chemical action of the sulphuric acid upon spongy lead; (2) the electrochemical action of the couple formed by the spongy lead of the active material and the lead (often containing antimony) of the support. The accidental presence of particles of lead peroxide from the positives, or of copper from the connections, also favours sulphating, whilst the action is in all cases much increased by the use of acid of high density. The results of experiments are given showing the influence of acid-concentration and of time on the sulphating of charged plates at rest. In many cases the extent of the action is greater than can be attributed to the above-mentioned causes, and is found to be due to the presence in the active negative material of iron, and, more especially, of antimony. The latter is derived from the alloy of which the grids are composed, and is found almost entirely in the superficial layers of the active material. The experiments quoted show the great influence of small percentages (under 1 per cent.) of antimony upon the sulphating, especially in combination with acid of high density. It is recommended that soft lead, free from antimony, be employed for the positive plates, or, if this is impossible, that electrolytes of low density be used. It is often advisable to remove the superficial layers of spoilt negatives, notwithstanding the decreased capacity caused by this operation. J. W.

1268. *Comparative Cost of Ozone.* **J. B. C. Kershaw.** (Elect. Rev. 43. pp. 151–153, 1898.)—The writer gives, first, brief descriptions of each of the five following forms of ozoniser:—Andréoli, Otto, Yarnold, Siemens & Halske, Tindal & Van der Steen. Details of these have previously appeared in the Technical papers, and in the case of the Otto and Yarnold ozonisers have received notice in 'Science Abstracts' (see Nos. 190 & 426). The proposed applications of ozone are then enumerated, and these are submitted to a detailed examination as regards comparative costs of ozone and the oxidising agents at present in use for the purposes named. The two following tables give, in condensed form, the results of the writer's calculations:—

TABLE I.

Form of Ozoniser.	Yield of Ozone in grams per E.H.P. hour.	Cost of Electrical Energy in pence	
		per kg. Ozone.	per kg. Active Oxygen.
Yarnold	175	8·56	25·68
Otto	150	9·99	29·99
Andréoli	90	15·90	47·70
Siemens & Halske	20	75·00	225·00
Theoretical Figures	1000	1·50	4·50

TABLE II.
Comparative Costs of 1 kg. Active Oxygen

Source.		Cost in pence.
Bleaching Powder		18·3
Sodium Bichromate		48·0
Ozone.	Yarnold's Ozoniser	61·5
	Otto's Ozoniser	66·0
	Andréoli's Ozoniser	83·7
Sodium Manganate.	Acid Solution	86·0
	Alkaline Solution	153·0
Ozone.	Siemens & Halske's Ozoniser	261·0

The writer holds that these figures prove

(1) That bleaching-powder is still the cheapest oxidising agent, and that for those purposes for which it is applicable and gives good results it will not be displaced by ozone.

(2) That ozone will be a keen rival to sodium bichromate and sodium manganate in the manufacture of oils, fats, and

organic products, and that in time it will probably displace these chemicals.

(3) That the extended application of ozone for producing results at present obtained by atmospheric influences—as, for instance, the purification of water, maturing of wines and spirits, etc.—is uncertain, and that further trials may result in failure due to economic and chemical causes.

AUTHOR.

1269. *Ozonisers.* **E. Andréoli.** (Électricien, 15. pp. 369–374, 1898.)—Andréoli's new ozonisers consist of plane aluminium plates and of aluminium plates built up of toothed ribbons, separated from one another by glass plates. Each plate has a total surface of 4 sq. ft. There are 17,760 points on the two surfaces of a ribbon-plate. Five of these point-plates and six plane plates are held by a wooden frame. The arrangement is vertical, and the ozoniser stands over the air inlet. Laboratory apparatus are put in glass cases; large batteries in rooms, whose walls are lined with glass or with enamelled bricks. The pointed-plate batteries are 30 per cent. more efficient than batteries containing only plane electrodes. A primary current of 2·45 amperes at 25 volts, and a secondary at 3000 volts, give good results. These currents do not produce much heat, nor do they cause oxidation of the nitrogen. The average yield is 125 g. of ozone per kilowatt-hour. The air arrives under pressure; further particulars about circulation are not given. H. B.

1270. *Electro-Deposition of Zinc.* **S. Cowper-Coles.** (Electrician, 41. pp. 382–383, 1898.)—The author of this short article gives the results of some experiments he has carried out in connection with the electro-deposition of zinc. A special cell was constructed with a revolving aluminium kathode, upon which zinc was electro-deposited from a zinc-sulphate solution, various gases being passed over the kathode during deposition, such as oxygen, air, carbon dioxide, coal-gas; the chief object of the experiments being to throw some light on the vexed question of the formation of zinc sponge. The best deposits were obtained with coal-gas and carbon dioxide. AUTHOR.

1271. *Electrolytic Refining of Lead.* **S. Cowper-Coles.** (Electrical Review, 42. pp. 779–780, 1898.)—The author reviews a number of processes that have been tried for the electrolytic refining of lead, and gives some details of the processes that have been worked by Keith, Tomassi, and Maxwell-Lyte. AUTHOR.

GENERAL ELECTRICAL ENGINEERING.

1272. *Practical Working of Accumulators.* **L. Gebhard.** (Zeitschr. Electrotechn. Wien, 16. pp. 261-265 & 277-280, 1898.)—After a brief historical introduction, the author deals with the improvements introduced during the past few years into the manufacture of the peroxide plates, the construction of the cell as a whole, and the management of cells. The gradual evolution of the modern type of Planté plate is fully considered, and its advantages over the pasted form of plate are pointed out. The application of modern accumulators capable of giving a high rate of discharge to electric traction is next considered; and the Hanover system is instanced as a successful example of what may be done in this direction. A. H.

1273. *Insulation and Conduction.* **R. A. Fessenden.** (Amer. Instit. Elect. Engin. 15. pp. 204-227, 1898.) Part II.—This is mostly a statement of facts and experience with regard to insulators. Rubber and ebonite are objectionable, because their surface becomes acid. It may be protected with paraffin. Glass is objectionable, because the alkali in it has a great affinity for moisture; also the angle of contact between water and glass is zero, and a drop of water spreads indefinitely. Quartz fibre is invaluable, because the water slides off. There is no reason why a suitable glass should not be designed. Porcelain with a non-alkaline glaze is excellent. For insulating coils paraffin is objectionable; its large coefficient of expansion strains the delicate wires. Rubber in contact with copper rots.

Manganin and constantan are unsatisfactory resistance-materials; pure lead run into glass tubes and kept in water has been adopted for standard resistances. Paraffin is best for condensers, and will stand 500,000 volts per inch.

Homogeneity in a dielectric is essential to volt-resistance. Thus, introducing a plate of glass into an air dielectric which is on the point of rupture under a high voltage alternating will precipitate that rupture.

The specific inductive capacity of oils may be reduced by expelling all the water. Silk should never be used in induction-coils where pure cotton can be had. The author considers that J. J. Thomson's discovery of the greatly increased dielectric strength of air with increased pressure should be used for cable-work. Thus air at 90 lbs. per sq. inch is equal to good rubber. Ice as a dielectric for cables is also suggested. Armatures may be insulated with asbestos string soaked in silicate of soda.

Insulation may be applied to cloth as a backing, but water creeps in at the edges and where the little tubes of cellulose protrude. Similarly with impregnated cloth (using, say, varnish dissolved in alcohol) the material in the tubes becomes filtered free of the gum, and will not be protected from water, which will be sucked up by the tubes. For impregnation no substance may be used dissolved in another substance. Few substances which melt are elastic: there is a valuable exception, viz. imitate, commonly called gilsonite. It mixes with paraffin. Linseed oil has the advantage of expanding on drying, thereby filling the pores of any cellulose it may be used upon. No *lead* drier must be used with it, and for armatures pure raw oil is best. Time is gained by the employment of borate of manganese as a drier. The pure linseed oil is boiled at about 200° for several hours with ½ % of borate of manganese till it begins to thicken. It always remains sticky.

A useful soldering-fluid is obtained by dissolving rosin in strong ammonia and using the soap as flux. An alarm against overheating can be made by imbedding a spring and contact in carnauba wax. The wax remains solid up to the danger-point, and suddenly melts.

[For the first part of this paper, see Abstract No. 1249.]

M. O'G.

1274. *Chapman Pressure Regulator.* (Amer. Electn. 10. pp. 226, 227, 1898.)—This regulator comprises a series of resistance-coils to be inserted or removed from the field-magnet circuit of the generator to be regulated. These coils are connected to a series of copper segments placed in a horizontal row and having a contact-slider arranged to move over their surface. The contact-slider is operated by being mechanically connected to the moving core of the working solenoid, which consists of two differentially-wound coils placed on the ends of a horizontally arranged brass tube closed at each end. Inside the tube is fitted a soft iron plunger, to the centre portion of which is attached a rod passing out through a longitudinal slot in the middle part of the tube, and having the contact-slider secured to it. The motion of the plunger is damped by filling the spaces at the ends of the tube with oil and connecting these ends through a small pipe having a valve in it so as to regulate the flow of oil. The action of the differentially-wound coils on the iron core is controlled by a small auxiliary solenoid, which causes an arm to oscillate in one direction or the other and close the circuit of one or the other of the said coils. This auxiliary solenoid can be shunt-wound, "compound-wound" to regulate for constant potential at a distant point on the line, or series-wound for constant current. It will work to 1 per cent. with continuous currents and ½ per cent. with alternating currents. It is made by the Belknap Motor Co., of Portland, Maine, U.S.A.

C. K. F.

1275. *Liquid Resistances.* **G. Dary.** (Électricien, 15. pp. 273–275, 1898.)—This paper discusses the advantages and disadvantages of liquid resistances with acid and alkaline electrolytes, and describes some experiments made in Baltimore, U.S.A., with a resistance consisting of two cylinders of galvanised iron mounted concentrically on a vertically-adjustable frame and cut off obliquely towards their lower ends, so that the surface wetted increases gradually as the cylinders are immersed, the current passing from one to the other through the liquid. C. K. F.

1276. *Electric Revolution-Indicator.* **G. Dary.** (Électricien, 15. pp. 292–293, 1898.)—This indicator, devised by M. Cadiou, serves to indicate each revolution made by the propeller-shaft of a vessel and also the direction of rotation. For this purpose, it comprises a rod pivotally supported at or near its centre, and normally held with one end midway between two contacts by means of springs, the other end of the rod being provided with a roller adapted to be acted upon by a cam on the propeller-shaft. By these means, for each revolution of the shaft, the rod can be caused to touch one or other of the contacts and, by suitable connections with the lighting circuits of the vessel, to intermittently illuminate one or other of two incandescent lamps, according to the direction of rotation. By counting the number of times the particular lamp lights up in unit time, the speed of the shaft can be determined. When the intermittent illumination is transferred from one lamp to the other, it can be seen that the engines have been reversed. It has been found to work satisfactorily, during a six months' trial, up to 110 revolutions per minute, on board the 'Condor.' C. K. F.

1277. *Electric Heater.* (Amer. Electn. 10. pp. 228–229, 1898.) —In this heater the resistance-wire is looped backwards and forwards over alternating or "staggered" projections on circular porcelain blocks having square central holes and threaded onto a a square iron bar to prevent rotation, the wire extending round an arc of about 200° between each projection. A clear photograph of the core is given in the original paper. C. K. F.

1278. *Penmarch-Eckmuhl Electric Lighthouse.* **C. Du Riche Preller.** (Engineering, 65. pp. 551–552, 623–626, 1898.)—In this article the author describes, first, the site of the new lighthouse, the tower (which is 63 metres high), and the buildings adjacent thereto. The two engines for driving the dynamos and air-compressor are of the semi-portable Rouffet type, and each develop 12 effective H.P. They are provided with Monin's condenser, which consists of a system of metallic pipes surmounting the engines and permitting 75 °/ₒ of the vaporised water being recovered (see 'Engineering,' July 7th, 1893, p. 10). The engines drive the two alternators, and the air-compressor by belting, and through the same countershaft. The air-compressor is of the Genty type, and supplies air through accumulators to a syren.

The alternators were designed by Prof. Blondel, and are made with two-phase winding so as to be capable of feeding two separate arc-lights in such a manner that the lighting or extinction of one light cannot affect the other. The alternators are each of 2·2 kilowatts, run at 810 to 820 revolutions per minute, have 8 poles, the resistance of each circuit is 0·213 ohm, and the intensity of the field 4000 C.G.S. units. They are excited by small continuous-current machines whose armatures are wound on the alternator shafts. The main feature of the plant is the double optical apparatus, in which two complete arc lamps and optical systems are placed side by side. This was adopted since it has been found that, after a certain point is reached, the ratio of increase of luminous power in single apparatus is much smaller than the corresponding increase of electrical energy: thus a twin apparatus at 50 amperes in each lamp will be more economical, and will at the same time give more luminous power in the beam than a single apparatus at 100 amperes. The twin 4-panel apparatus of Penmarch has 6 dioptric and 10 catadioptric elements to each panel, with a focal length of 300 millimetres. The twin apparatus, weighing about 2 tons, is mounted on a platform revolving on the same shaft, to which is fixed a drum revolving in a mercury bath. On testing the apparatus, the following results were obtained:—

	Minimum Candles.	Maximum Candles.	Mean Candles.
10 mm. carbons	20×10^6	$26{\cdot}6\times10^6$	$23{\cdot}2\times10^6$
16 " "	30×10^6	$40\ \times10^6$	$35\ \times10^6$

By comparison the luminous power of the La Hève single apparatus (see 'Engineering,' July 14th, 1893, p. 41) is as follows:—

	Minimum Candles.	Maximum Candles.	Mean Candles.
10 mm. carbons	9×10^6	12×10^6	$10{\cdot}5\ \times10^6$
16 " "	$13{\cdot}5\times10^6$	18×10^6	$15{\cdot}75\times10^6$
23 " "	$17{\cdot}25\times10^6$	23×10^6	$20{\cdot}15\times10^6$

Thus the compound beam of the twin apparatus, with 16 mm. carbons at 50 amperes in each arc, has a mean luminous power of 35×10^6 candles, whilst the La Hève single apparatus gives, with 23 mm. carbons at 100 amperes in single arc, a mean luminous power of $20{\cdot}15\times10^6$ candles, the ratio of increase being therefore 1 : 1·7.

Two 2-page plates of drawings of the lighthouse buildings and plant are given with the original paper. C. K. F.

1279. *Electric Capstans.* **E. Sartiaux.** (Écl. Électr. 15. pp. 459–469, 1898.)—This paper gives a description, with clear drawings, of electric capstans in use on La Compagnie du Chemin de Fer du Nord, and comprise (1) a capstan proper for haulage; (2) a direct-acting capstan for the rotation of turntables and swinging bridges; (3) a geared capstan for actuating a number of turntables or a hauling apparatus, as desired. In the first of these arrangements the hauling drum or head is mounted directly on the shaft of a series-wound 8-pole motor, mounted on a platform supported on trunnions in a cast-iron caldron-shaped base, so that it can be reversed for inspection or cleaning. The second arrangement is similar to the first, except that the motor-shaft is provided with a sprocket-wheel driving the turntable or swinging-bridge through a driving-chain; the sprocket-wheel on the motor-shaft is connected thereto through a friction-clutch, the sections of which are held in engagement with each other by means of a spiral spring, this arrangement allowing the motor to stop gradually, even when the motion of the turntable or bridge is suddenly arrested. In the third arrangement the motor-shaft is provided at its upper end with a hauling-drum or head, and also with a gear-wheel which gears with three pinions capable of being connected to sprocket-wheels by means of friction-clutches operated by electro-magnets, the said sprocket-wheels driving turntables or swing-bridges through chains. The motors are driven from accumulators, a kilowatt-hour costing about 0·2 f. (1·9*d.*), the cost of each operation of a capstan varying between 0·004 and 0·005 f. The first type costs 5500 f. (£220), the second 6500 f. (£260), and the third 9000 f. (£360); this comprises the switches and conductors. The supply is at 100–110 volts, the normal current varies from 30–35 amperes for a pull on the cord of 400 kilos, and 70–75 amperes for 1000 kilos; the motor-shaft making 12–16 revs. per min. The descriptions are full, and are supplemented by a number of clear drawings and curves. C. K. F.

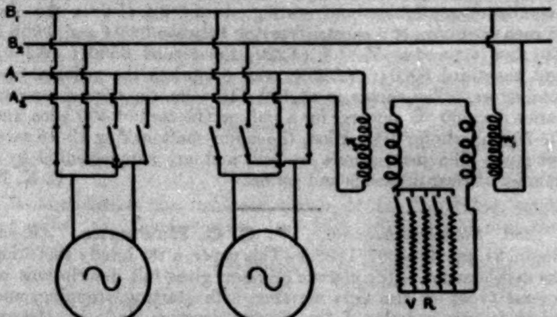
1280. *Electric Elevators.* **W. C. C. Hawtayne.** (Elect. Engin. 21. pp. 693–697, 1898.)—This paper, after briefly sketching the development of the electric elevator, gives full descriptions of several types of the Otis elevator, with starting, stopping, and safety devices, and also of the electric elevators made by Messrs. Waygood & Co., Messrs. Easton, Anderson & Goolden, and the Sprague Electric Company. C. K. F.

1281. *Communication between Railway-trains in Motion.* **J. Buse, Jr.** (Électricien, 15. pp. 293–295, 1898.)—The author describes briefly the systems of communicating between trains in motion devised by Alexandre Lefèvre (see 'Revue pratique de l'électricité,' 5th March, 1897), Messrs. Royse Bros. (see l'Électricien, 20th November, 1897, p. 336), and an American system described in l'Électricien, p. 71, 1st vol. 1898. C. K. F.

1282. *Combustion and High-Compression Motors.* **A. Witz.** (Comptes Rendus, 126. pp. 957–959, 1898.)—Explosion motors had almost caused combustion motors (Siemens, Brayton, Simons, Crowe, Foulis, Gardie, etc.) to be forgotten; but Diesel has recalled attention to their efficiency. The author refers to his paper in Ann. de Chim. et de Phys. vol. 30. 1883, in which Diesel's results were stated. The secret of Diesel's success is that he has secured high compressions; these being attained the classical cycle without modifications will provide equal efficiencies. A. D.

DYNAMOS, MOTORS, AND TRANSFORMERS.

1283. *Paralleling of Alternators.* **G. Frisch.** (Zeitschr. Elektrotechn. Wien, 16. pp. 227–228, 1898.)—Referring to Sahulka's article (see Abstract No. 861) on this subject, the author states that the method illustrated in the accompanying diagram has been in use at the Vienna central station since 1893, and has given very satisfactory results. B_1 and B_2 are the main bus-bars, while A_1 and A_2 are two auxiliary bars connected to rheostats forming an artificial load, and to the fine-wire winding W_2 of a synchronising transformer whose other winding may be connected, through a variable resistance VR, to the secondary of another transformer whose primary winding W_1 is across the main bus-bars. The alternator having been run up to full speed, it is connected across the auxiliary bars, and is then, by suitably adjusting the artificial load and exciting current, brought into approximate equality of phase and P.D. with the mains (the usual lamp-signal method being employed for this purpose). The secondaries of the synchronising transformers are then closed, and the resistance between them reduced step by step, the incoming machine being thereby brought into perfect phase-relation with the mains. The output of the synchronising transformers need not exceed 2½ °/ₒ of the alternator output. A. H.



1284. *Single-Phase Alternating Current Motors.* **E. C. Hoadley.** (Elect. Rev. 43. pp. 66–68, 1898.)—This is an article on the performance of the single-phase motors working on the Worcester supply mains. The maximum load on the station is 330 kilowatts, and of this 120 kilowatts are supplied by means of water-power, the remainder being accomplished by steam. The current is generated at 2000 volts at a frequency of 100 cycles per second, and is distributed at 100 volts. The motors driven from the station aggregate 100 H.P.: of these some are synchronous and some induction motors made by the Oerlikon Company and the Langdon-Davies Motor Company. Little difficulty is experienced in the regulation of the plant unless a motor is suddenly switched on during a period of light station-load. During periods of light load it is found profitable to supply current for motive power at 1½*d.* per unit. When motors are run during periods of heavy load the charges are as follows:—

Not exceeding 1000 units per quarter, 3*d.* per unit.
Over 1000, not exceeding 2000 units per quarter, 2½*d.* per unit.
Over 2000, not exceeding 5000 units per quarter, 2*d.* per unit.
Over 5000 units per quarter, 1½*d.* per unit.

And for motors which do not use as many units as a one-hour's daily use of their maximum demand, 6*d.* per unit.

The power-factor of the Worcester plant varies from 0·5, when the load is light and composed chiefly of motors, to 0·98, when the load is chiefly incandescent lamps. The efficiencies of the motors vary from 75 to 84 per cent. according to their sizes. If the load of an alternating-current station consists partly of motors, the alternators should have no iron in their armatures, otherwise there will be considerable variation in the lights on switching on motors. W. G. R.

1285. *Induction Motors with Large Starting Torque.* **M. Déri.** (Zeitschr. Elektrotechn. Wien, 16. pp. 285–290, 1898.)—After a brief sketch of the theory of induction-motors, the author explains a neat graphical method of obtaining the torque-speed curve of such motors. He then proceeds to consider the one weak point of high-efficiency induction-motors, viz. their small starting torque. In starting against a load it becomes necessary to introduce resistances into the armature circuit; these are gradually cut out as the motor gains speed. The usual methods of accomplishing this result cannot be considered quite satisfactory, as they involve considerable complications. The author has solved the problem in an exceedingly ingenious manner. Briefly stated, the method consists in halving the number of poles in the motor-field at starting, and when the motor has run up to about its normal speed, changing the field-connections (by a single movement of a suitable switch) so as to produce the normal number of poles. To explain the principle of his method, the author considers the simple case of a 4-pole polyphase motor. Fig. 1 represents a group of 4 conductors forming one element of the induced winding. It will be readily seen that if such a winding is subjected to the inductive action of a 2-pole field, there will be no resultant E.M.F. in any position. Let now a cross-connection be introduced, as in fig. 2. The effect of this is to transform the group of 4 conductors into what is practically a single closed loop consisting of 2 parallel branches. With a

2-pole field, currents will now appear in the conductors, and a torque will be produced. By making the cross-connection of sufficiently high resistance, the starting torque may be made very large. When the motor has run up to speed, the field-connections are altered so as to produce a 4-pole field, as in fig. 3. The effect of this change is to alter the parallel arrangement of the conductors to a series one, and to *completely arrest the current in the cross-connector*. The latter, in fact, takes no part in the action of the motor when running under normal conditions. The advantages claimed by the author for this method are: a simple form of induced winding, requiring no high insulation, and the entire absence of collecting-rings, rheostats, and multiple-contact starting switches.—The principle of the method is equally applicable to single-phase induction motors; but the arrangements are then more complicated, a commutator and brushes being required at starting. The author describes two different designs for a 4-pole single-phase motor.

A. H.

Fig. 1.

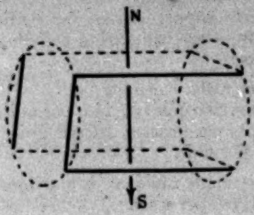


Fig. 2.

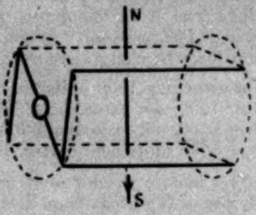
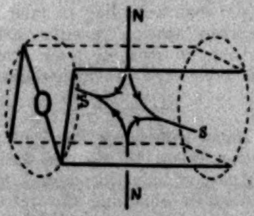
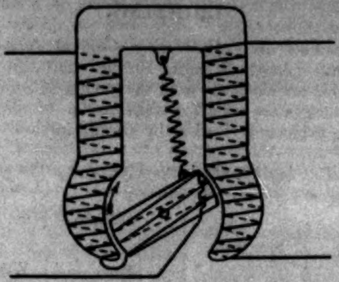


Fig. 3.



1286. *Transformer with Variable Ratio of Transformation.* (Elekt. Runds. 15. pp. 177–178, 1898.)—The object of this device, recently patented by A. Nicolaysen, is to secure constancy of secondary P.D. with variable secondary current, thus compensating (in an automatic manner) for the drop in the transformer itself and



the mains connected to it. The mode of action will be evident from the subjoined sketch. A. H.

1287. *Regulating Transformers.* **G. W. Meyer.** (Elekt. Runds. 15. pp. 192–195, 1898.)—The author briefly refers to the various devices, such as those due to Stillwell and Kapp, for maintaining a constant P.D. at the feeding-points of alternate-current networks. He then describes an arrangement of his own, which mainly differs from those hitherto proposed in that the secondary of the regulating transformer is connected across the feeding-points and not in series with the feeders. The device is illustrated in fig. 1. It will be seen that two auxiliary mains are required, of sufficient cross section to carry the maximum "equalising" current. Fig. 2 shows an application of the same principle to the problem of maintaining equality of P.D. between any two feeding-points of a network; while fig. 3 shows how such an "equalising" transformer may be applied to a 3-wire network. A. H.

Fig. 1.

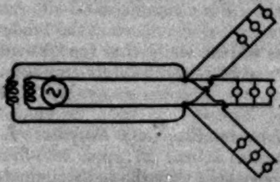


Fig. 2.

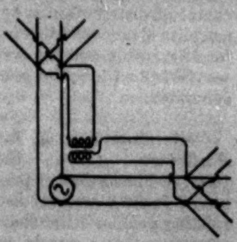
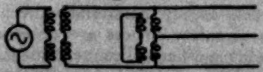


Fig. 3.



POWER DISTRIBUTION, TRACTION, AND LIGHTING.

1288. *200-Volt and Alternating Current Systems.* **G. D. Shepardson.** (Amer. Electn. 10. pp. 249–251, 1898.)—The first part of this article deals with the saving of copper in the line when high voltages are used for transmission of electrical energy. The following table is arrived at by calculation:—

Wire for delivering 10,000 *watts* 1000 *feet at* 10 *per cent. loss.*

Volts delivered.	Size Wire.	Weight of Wire, in lbs.	
		Bare.	Weatherproof.
100	0000	1240	1460
110	000	1014	1176
120	00	804	952
220	4	252	320
1100	18	10	22
1100	10	63	102

The second part is a comparison between the 220- and the 110-volt system. Forty-six arguments are advanced in favour of the 220-volt system and twenty-nine against it; but, as the author says, many of them are matters of opinion and depend often upon the quality of work turned out by manufacturers of lamps, etc. The author advocates the use of alternating-current high-tension systems where the distance from the generating station to the centre of distribution is appreciable. For a plant with 60-kilowatt machine about 3600 feet from the centre of distribution, the tender for alternating-current system was $5100, while that for 220-volt was $5742 with belted generator, and $6242 with direct-connected generator. W. G. R.

1289. *Prevention of Interruptions to Electricity Supply.* **L. Andrews.** (Instit. Elect. Engin. Journ. 27. pp. 487–523, 1898.)—The author of this paper contends that the indiscriminate use of fusible cut-outs is almost entirely responsible for the still existing popular belief that electricity supply is unreliable. Whilst admitting that a certain number of safety devices are necessary, he considers that these, and all other mechanical connections in an electric circuit, should be reduced to a minimum. Particular attention is drawn to the uselessness of fuses between primary or secondary generators and the bus-bars they supply, since it almost invariably happens that when a generator does fail the fuses of the healthy generators are blown before those of the faulty one. It is recommended that these fuses should be replaced by discriminating cut-outs—that is to say, by cut-outs that will not be operated by any amount of current supplied from the generator to the bus-bars, but that will disconnect a failing generator from the rest of the system immediately it attempts to rob current from the other generators. Cut-outs that have been designed especially for this purpose are illustrated and described. It is shown that these special cut-outs are able to discriminate between a generator and a motor current, even when used for alternate-current work, in spite of the fact that the direction of the current in this case is normally constantly being reversed. Great attention has been paid to the mechanical details of these cut-outs, to ensure absolute reliability. It is shown that no amount of mechanical vibration can possibly cause them to operate; on the other hand, a very small motor current will do so.

A novel system of Electricity Distribution is also described. This consists of a number of substations or feeding-points connected together in such a manner that each point is fed by two or more feeders. Discriminating cut-outs are inserted in series with each feeder at the substation end, and these, in conjunction with fuses at the generating-station end, operate to automatically disconnect any feeder in the event of its becoming short-circuited. It is shown to be possible by this arrangement to short-circuit any feeder at any point without interrupting the supply to any lights.
AUTHOR

1290. *Halifax Electric Tramway.* (Electrician, 41. pp. 349–354, 1898.)—An illustrated account is given of this municipal system, where the traction plant has been combined with a 2000-volt alternating-current lighting system. A 120 kw. tramway generator is rope-coupled to a 100 kw. E.C.C. alternator as a motor generator. Running off the cells it can supply the day lighting-load, or off the alternating bus-bars as a synchronous motor it can supply the tramway. Separate cells are used for exciting purposes. The tramway battery contains 270 63-plate chloride cells, and has a capacity of 200 amperes for six hours. There are now ten 44-passenger cars running over four miles of track, mostly on a gradient of 1 in 18. Besides hand-brakes and electric brakes, there is a pair of slipper brakes consisting of wood blocks which are forced down on to the rails between the leading and trailing wheels. The Electric Light Committee provide plant and lay feeders, charging the Tramways Committee 2*d.* per unit for power, this charge including interest and sinking-fund. E. H. C.-H.

1291. *Paris Electric Tramways.* **R. T. Collins.** (Elect. Engin. 21. pp. 486–488, 1898.)—This article forms part of a contribution to the *Contract Journal.* The author gives an account of the line working on the accumulator and mixed systems. Also of the line from the Place de la République to Roumainville, working on the Claret Vuilleumier surface-contact system. The article concludes with a comparison of the cost of steam and electric tramway traction. W. R. C.

1292. *Earth Returns for Electric Tramways.* **H. F. Parshall.** (Instit. Elect. Engin. Journ. 27. pp. 440–456, 1898.)—A series of tests were undertaken in order to determine the conductance of the return system of electric tramways, consisting of rails laid on a concrete bed in the usual way, and in order to locate definitely the different elements of resistance. The following is a summary of the tests:—

(1) Specific resistance of a steel rail and its variation with chemical composition.
(2) Determination of the resistance of the joints.
(3) Determination of the relative conductivity of the track-rails and the earth.

Referring to No. 1, namely, specific resistance of steel rails, a table is given which shows the variation of resistance with chemical composition. Generally speaking, resistance varies with the amount of carbon and manganese. The resistance of steel rails, as manufactured at the present time in England, is about eleven times that of copper at 20° C., the following being the chemical composition:—

Carbon	·4	to	·5
Manganese	·95	„	·85
Silicon	·1	„	·06
Phosphorus	·1	„	·08
Sulphur	·08		

Referring to No. 2, *i. e.* determination of the resistance of the joints, the resistance of the rail-joints is made up of the resistance due to the gathering of the current towards points of contact of bond and fishplate, together with the resistance of contact of the fishplate and bond. Taking a 76-lb. rail as an example, with a fishplate 20″ long, and using Chicago bonds of No. 0000 copper, the following is a statement of various elements of conductance in the joints:—

	Resistance per joint.	Conductance per joint.
Fishplates alone	·0000826	12100
One 30″ Chicago bond. 0000 B. & S. alone	·000103	9700
Two 30″ Chicago bonds. 0000 B. & S.	·0000515	19400
Fishplates and one bond	·000046	21800
Fishplates and two bonds	·0000317	31500

Roughly, the resistance per mile of a 76-lb. rail, made up of 30′ lengths, is as follows:—

Resistance per mile of 76-lb. rail, = ·0615
With fishplates and without bonds, = ·076
With fishplates and one bond, as above, = ·0696
With fishplates and two bonds, as above, = ·0671

The efficiency of the different bonds was also determined, and a table given showing a comparison between Chicago bonds, Crown bonds, Columbia bonds, and Plastic bonds. The relative efficiency of different methods of jointing the rails is also discussed; and the electric welding of joints and the cast weld joint is compared with an ordinary fishplate joint.

Referring to No. 3, *i.e.* determination of the relative conductivity of the track-rails and the earth, tests were made by means of the potentiometer method, and also by inserting an ammeter in the rails at different sections on the line, to determine the amount of stray current at different distances from the source of supply. Generally speaking, it is found that a third of the whole current put into the rail at one end strayed into the earth, returning again into the rail and concentrating towards the point at which the current was drawn out of the rail, so that the voltage drop measured between the near and distant ends of the rails was only about two-thirds of what it would have been had the currents been wholly in the rail. The influence of this upon electrolysis of water-pipes and gas-pipes is discussed. It was also proved that the conductivity of the earth is so large compared with the conductivity of a system of water-pipes and gas-pipes in the earth, that the pipes themselves take but a small proportion of the total stray currents.
AUTHOR.

1293. *Rail Bonding.* **H. C. Chase.** (Street Rly. Journ. 14. p. 224, 1898.)—This paper is an abstract of one read before the Texas Street Railway Association. The author draws attention to the great waste of electric energy caused by imperfect bonding. The Houston Electric Street Railway Company has obtained good results with No. 0 tinned copper wire and 19-32 in. channel-pins.
W. R. C.

1294. *Life of Sleepers.* **D. D. Willis.** (Street Rly. Journ. 14. pp. 225–226, 1898.)—This is an abstract of a paper read before the Texas Street Railway Association. At San Antonio cedar sleepers have been found in perfect condition after 20 years. In a moist climate cypress lasts as well as cedar, but in a dry climate they are no better than sap-pine. Heart-pine lasts from 5 to 8 years, cedar from 25 to 30 years. Heart-pine would probably last well if treated with carbolinum (or C.A. wood-preserver). The author's experience relates to such conditions as are found in Texas.
W. R. C.

1295. *Oscillation of Cars.* **J. H. Brill.** (Street Rly. Journ. 14. p. 226, 1898.)—The author discusses the oscillation of cars, and opposes the theory put forward by a previous writer in the 'Street Railway Journal' (see Abstract No. 721). Soft journal-springs should be avoided, thus diminishing the oscillation by causing the body to oscillate upon the longer base provided by the body-springs.
W. R. C.

1296. *Patton Motor Tram-Car.* (Street Rly. Journ. 14. p. 226, 1898.)—Figures are given relating to the test of a Patton car, which was run 274·1 miles on the Great Western Railway (U.S.A.). The time taken in running this distance, omitting stops, was 16 hrs. 45¼ min. Taking gasoline at 5 cents (2½*d.*) per gallon, the cost of fuel amounted to $1\frac{1}{17}$ cent (0·53*d.*) per car mile, or $0·00064 (0·032*d.*) per ton mile. W. R. C.

1297. *Tram-car for Mixed Traction.* (Railway World, 7. p. 85, 1898.)—Brief description of the new cars used in Paris. They are carried on Brill bogie-trucks, so constructed that 80 % of the weight is supported by the two driving-wheels. W. R. C.

1298. *Elieson-Naylor Controller.* (Elect. Rev. 43. pp. 149–150, 1898.)—Simplicity, ease, and reliability of contact are claimed for this controller, which is intended for any electrically propelled vehicle. By the addition of an auxiliary switch operated by depressing the controller handle, the circuit can be made or broken at any moment, thus reducing the time necessary to start or stop the vehicle. A simple foot-switch is also illustrated, intended for reversing the motor or for an electric brake. E. H. C.-H.

1299. *Electric Lighting of Edinburgh.* **F. A. Newington.** (Elect. Engin. 22. pp. 41–43, 1898.)—This is a paper read before the Incorporated Association of Municipal and County Engineers at Edinburgh. The Edinburgh Electric plant is capable of supplying 2680 kilowatts direct current and 468 kilowatts alternating current. The following details of the financial results are of interest:—

Price per Unit.

1895–6	Lighting	6*d.*	per unit.	Power	3½*d.*	per unit.
1896–7	„	5*d.*	„	„	3*d.*	„
1897–8	„	4*d.*	„	„	2*d.*	„
1898–9	„	3½*d.*	„	„	1½*d.*	„

Units sold each year.

	1895–6.	1896–7.	1897–8.
Private lighting	556,744	1,052,570	1,973,315
Power.....................	13,914	47,727	86,654
Public lighting	331,043	621,276	834,660
Total	901,701	1,721,573	2,894,629

Capital expenditure, £282,000.

Year.	Net Profit.
1895–6	£3976
1896–7	£3374
1897–8	£2000 to £3000 (estimated).

W. G. R.

TELEGRAPHY AND TELEPHONY.

1300. *Selector System of Circuits.* **J. Voisenat.** (Écl. Électr. 15. pp. 393–400, 1898.)—This is a system for operating any one of a series of local circuits on a single line, independently of the others. Each local circuit is controlled by a rotary electromagnetic switch, designed to rotate by steps as dots and dashes are received from line. To each switch corresponds a certain sequence of dots and dashes; if this particular sequence is "received," the switch actuates the local circuit; but for any other sequence the switch has no effect on the local circuit. The sending arrangement on the line-circuit is "automatic;" the sequences of dots and dashes are represented by teeth in the edges of rotating discs, any one of which can be brought into play, according to the particular local circuit to be operated. As a matter of detail, there are two discs on the "sending" apparatus, corresponding to each local circuit; so that positive and negative signals take the place of dots and dashes. R. A.

1301. *Hertzian Telegraphy: Receiver.* **E. Ducretet.** (Comptes Rendus, 126. pp. 1266–1268, 1898.)—Description, with drawing, of apparatus made to act automatically, unrolling the paper when the waves come and stopping when the signalling ceases, and recording the message in longs and shorts. A. D.

1302. *Hertzian Telegraphy.* **G. Goisot.** (Écl. Électr. 15. pp. 370–371, 1898.)—A sketch of the early work done by Popoff in this department. A. D.

1303. *Telephone Exchange at St. Louis.* **F. E. Bausch.** (Elect. Engin. N. Y. 25. pp. 417–424, 1898.)—Describes the new system of the Bell Telephone Co. of Missouri. Underground cables have been substituted for overhead wires. The Western Electric Co.'s common battery system replaces the Law system of communication previously in use. The equipment of the switchboard is for 4000 subscribers. The article describes in detail the various features of a modern telephone exchange. J. E. K.

1304. *Telephone Exchange Lines.* **P. Heina.** (Écl. Élect. 15. pp. 103–107, 1898.)—When the overhead wires of a telephone exchange system become congested, the further increase is usually best met by running cables to distributing points, whence the subscribers are reached by short overhead wires. The resulting lines are longer than on a direct course, and a formula is suggested for determining the frequency of distributing points so as to limit the increase in the line distance. An illustration of the method is given as applied to the town of Marseilles. J. E. K.

1305. *Temporary Switchboard.* (Elect. World, 31. p. 468, 1898.)—The equipment is described of the new Exchange known as the John Street Exchange recently opened in New York. Pending erection of the permanent multiple switchboard of the Common Battery type, the Exchange has been fitted with a board of the divided type. Each operator has before her only the jacks and drops of her own subscribers, and is not, as in the Multiple boards, within reach of the spring jacks of all the subscribers on the board. The subscribers are multipled on the Trunk boards. An answering operator asks for a trunk line, and connection is completed by the trunk operator. On completion of the permanent plant this temporary switchboard will be retained as an Emergency board in any exchange where it may be necessary to provide quickly a new equipment. J. E. K.

1306. *Inductance in Telephony.* **W. Moon.** (Elect. Rev. 42. pp. 502–504, 539–540, 1898.)—The author describes a method of measuring self and mutual inductance for telephonic currents, and gives a list of inductances for standard telephonic apparatus, with formula for calculating the impedance when the resistance and inductance of a circuit are known. The induction-coils used with telephones are not of the closed magnetic circuit type. The primary current of a telephone induction-coil is undulatory but not alternating, so that the inductances of such coils are single-current inductances, and it is necessary to use coils with broken magnetic circuits having but little residual magnetism. The sheathing of indicators and transformers acts in every way similar to a short-circuited secondary circuit. The cores of electromagnets act as secondary circuits in the same way as an iron sheathing, and for this reason telephonic induction-coils are provided with cores of iron wires oxidised on the surface. A more efficient core can be made by winding iron-foil up in a coil with paper between each turn. A transformer can be similarly made. Apart from a better insulation, more iron can be got in the same space.

J. E. K.